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Journal of the Society of Arts.

FRIDAY, JANUARY 15, 1858.

EXAMINATIONS.—NOTICE TO INSTITUTIONS.

No person who shall not have been for three months previously a member of, or student of a class in, an Institution in union with this Society, can be admitted to the Final Examinations. Moreover, to bring the Examinations within reach of the Members of *Incipient* Institutes and small Evening Classes for Adult Instruction, which cannot afford to pay two guineas for union with the Society of Arts, any Provincial Union or Association, or Local Board for the promotion of Adult Instruction, may unite with itself any number of such incipient Institutions and Small Evening Classes in its district, and give to the whole of them, but *not to fully developed Institutes*, the privileges of Union with the Society of Arts in respect of the Examinations, for a single annual payment of Two Guineas.

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The Committee are very desirous of obtaining instances of fraudulent or wrongful acts relating to works of Fine Art. Members and others in possession of such facts are requested to communicate with the Secretary of the Society of Arts.

CONFERENCE—EXAMINATIONS.

A Conference between the Council of the Society of Arts and the Representatives from the Institutions in London and its neighbourhood, was held on Monday, the 11th inst., at six o'clock. The chair was taken by C. Wentworth Dilke, Esq., V.P., and Chairman of the Council, who opened the meeting by explaining the object of the Council in convening it, and called upon

Mr. Harry Chester, V.P., who said that, however successful the Examinations hitherto conducted by the Society had been, as far as they went, yet it must be obvious, looking at the Institutions scattered as they were over all parts of the kingdom, that the system hitherto adopted did not give to their members the facilities for examination they had a right to expect. Last June there were two centres of Examination, one in London and one in Huddersfield. The result showed that only 37 Institutions availed themselves of them. Hence, the determination of the Council to adopt the present scheme, as detailed in the Programme which had been circulated to all the Institutions in the Union. The Council desired to throw some portion of the management of the Examinations upon the Institutions, feeling assured that it was greatly for the advancement of the Institutions themselves, that the Society should not do for them that which they could well do for themselves. Mr. Chester then pointed out the nature and duties of the Local Boards in connection with the scheme, as detailed in the Society's Programme, and stated that the Northern Union of Mechanics' Institutions, embracing the four northern counties, the Yorkshire Union of Mechanics' Institutes, the Institutional Association of Lancashire and Cheshire, the Hants and Wilts Adult Education Society, and the Bucks and Berks Association, were already possessed of an organisation, which was being brought into operation for forming Local Boards to co-operate with the Society. At Sheffield the Mayor had convened a meeting of Representatives of the Institutions in that town, and a joint committee had there been formed to carry out the Society's Programme. At Brighton a meeting was about to be held for the same purpose, and the Council were in communication with many other towns where the like proceedings were taking place. The present meeting was called to facilitate similar arrangements in the London districts. He suggested that it would be convenient that several Institutions in a district should form a joint Board. This Board need not be numerous. The duties it must *necessarily* discharge under the programme were very simple, though doubtless others, of great importance to the improvement of education, might well be discharged by such a Board when once formed. The necessary work would be—1st, To test the Candidates in the elementary subjects, and to ascertain whether they were likely to pass in the special subjects comprised in the papers to be sent by the Society's Board. 2nd. To superintend the working of the Society's papers by those candidates who had previously passed the Local Board, and to certify that the work had been done without copying, or the assistance of books, &c. Under these arrangements, it would be seen that the Candidates passed by the Local Board, would not have to leave their localities to be examined by the Society's Board; the papers would be sent down by that Board to be worked in their several localities. For these necessary purposes the Local Board need not be numerous; in fact, two or three gentlemen possessing the confidence of the Institutions could do the work. The committee of the Crosby-hall Evening Classes had already formed a Local Board, and were ready to admit to it the members of such Institutions as were disposed to join them, upon certain terms. The Polytechnic Institution was also ready to form a Local Board, and to admit such Institutions as thought it desirable to join that body.

A conversation then ensued, in which Messrs. Smurthwaite, Edwards, Chester, Rev. C. Mackenzie, Winkworth, Sir Thos. Phillips, Hamilton, Andrews, Rev. W. Bashall, Pearsall, Buckmaster, Rev. R. Whittington, Rev. W. Hodgson, and others took part, when it was moved by the Rev. Charles Mackenzie, and seconded by Mr. Edwards, and resolved *nem con.*

"That the Council invite the Secretaries of the various Institutions in London, in union with the Society of Arts, to meet at the Society's house, for the purpose of suggesting convenient places in which Local Boards may be formed."

A vote of thanks to the Chairman having been passed, the meeting separated.

SIXTH ORDINARY MEETING.

Wednesday, Jan. 13, 1857.

The Sixth Ordinary Meeting of the One Hundred and Fourth Session, was held on Wednesday, the 13th inst., Thomas Sopwith, Esq., M.A., F.R.S., in the chair.

The following Candidates were balloted for and duly elected members of the Society:—

Ames, Edward Levi, M.A.
Macadam, Charles Thos.
Odams, James.

The following Institution has been taken into Union since the last announcement:—

450. Sheffield Church of England Educational Institute.

The Paper read was:

ON THE ADVANTAGES OF A DAILY REGISTER OF THE RAINFALL THROUGHOUT THE UNITED KINGDOM, AND THE BEST MEANS OF OBTAINING IT.

By J. Bailey Denton, F.G.S., Assoc. Inst., C.E., Engineer to the General Land Drainage and Improvement Company.

It has often been said that Englishmen begin their best works at the wrong end, and acquire by dearly-bought experience the elementary knowledge upon which they should have started. There are few subjects to which this imputation is more justly applicable than the disregard of Rainfall in relation to many of the greatest agricultural, sanitary, and domestic improvements which have long taken a leading place in our attention. It may be fairly said that, within the last 20 years, we have heard more about the want of under-draining of land, the growing necessity for improved arterial drainage, the advantages of irrigation, the utilisation of water in rural and domestic economy, the defective sewerage of towns, and the waste of millions in the refuse, than perhaps we ever heard before; and though each may be said to involve a question of demand or supply, and neither drainage nor sewerage for the removal of surface water and town refuse can be conducted without providing for the maximum rainfall, nor any profitable application of water can be made without regard to the minimum, we are content to remain to this hour in comparative ignorance of the first great element—Quantity,—and to work out our problems without the principal datum.

This want of information is not owing to the absence of societies and commissions qualified to organise the means of obtaining it, for we have existing at the present moment the chartered Agricultural Societies, the Drainage Commissions, the Central Board of Health, and the survey department of the Ordnance—institutions all founded for objects which cannot be fully and properly attained so long as we remain in our present ignorance.

Does this apathy or inattention proceed from a disbelief that the information would be of sufficient practical value to warrant the necessary outlay to obtain it? It can hardly be so. In the returns of the Registrar-General, we find a recognition of the importance of the subject in the reports of upwards of 50 correspondents on the rainfall and other meteorological phenomena, upon which deductions are based, bearing upon the health and mortality of the country; and I think all persons must agree with Mr. Glaisher, that "there is scarcely an element in meteorology more important, or involving more beneficial interests to mankind, than a knowledge of the actual fall of rain," and that "it is desirable to know the kind of diseases peculiar to rainy districts," and "whether wet periods of the year exercise any appreciable influence on the growth and progress of disease." Every agricultural observer can furnish evidence of the important effect of excess and scarcity of water in the health and increase of domestic animals, and on the development of the vegetable productions of the country,[*] and this being so, there can be no doubt as to the value of a perfect knowledge of the quantity of rain at our disposal.

My object is to show how little we do know on the subject, and how unavailable that little is.

It was only in 1816, that the able author of "The Climate of Britain" (Williams), alleged that the climate of these islands was deteriorating in consequence of the increase of evaporating surface. Now the general belief is that the climate of these islands is improving, and the fall of rain becoming annually less, but we have no data to confirm the belief. It is not based on any meteorological records, but on the fact that the extent of woodland throughout the country is decreasing, the thick and numerous hedgerows (which were multiplied after the enclosure of the open lands, and which led Williams to think the climate deteriorating,) are giving place to the narrow, straight, and comparatively few fences which characterise good husbandry—our fens have been converted from inland lakes and rushy swamps, into highly productive arable lands, and drainage generally is extending; the imperfect and temporary practice of shallow drainage being abandoned in favour of permanent deep drainage. By all these acts of improved cultivation, we may safely presume evaporation is considerably diminished; and, the humidity of the country being much more dependent upon the extent of evaporation than on the quantity of rainfall, we may fairly assume the climate improved.[*] Beyond this, too, if when lessening evaporation by clearing the surface of woodland and by draining the soil, we reduce the rainfall—which would seem to be a natural consequence, were it not that the sea is so near at hand to replenish the atmosphere—another and equally potent reason is found for the assumed improvement.

The returns of the Registrar-General and the journals of the meteorological societies, are the nearest approaches to systematic records which have yet been attempted, but they include only the voluntary contributions of a comparatively few individuals, and from that circumstance and from the fact that they are necessarily distant and isolated, no practical utility results from their publication, beyond the interest they maintain on meteorological subjects among scientific men. Our scientific teachers and meteorological authorities, are still necessarily compelled to deal with the "mean" and "average" quantities of these and like returns, which in these sea-girt lands, so differently affected on different sides, with conditions of surface so various in elevation and geological structure, is a practice unworthy of the age in which we live, and wholly irreconcilable with the advanced and useful objects at which we aim.

And if this be so as to the quantity of rain that falls on the surface, the contradictory opinions and deductions which have been published and still prevail, as to the quantity of moisture evaporated from the surface are equally striking.

Mr. Daniel showed that "the amount of evaporation ($23\frac{1}{16}$ inches) very nearly equalled the quantity of rain (23·974) that fell in the vicinity of London."

Dalton says:—"Evaporation from land in general must be less than the rain that falls, otherwise there would be no rivers."

Professor Leslie found that evaporation was daily, in summer ·048, and in winter ·018.

Dr. Dobson, of Liverpool, showed that the evaporation from the ocean was 36·78;—and Mr. Charnock showed by his experiments that evaporation was much greater from saturated soil than from water. (See *Journal of Royal Agricultural Society.*)

Dr. Hugh Colquhoun, of Glasgow, showed that evaporation took 14 inches out of 26 inches rainfall.

The Central Board of Health assumed in their Report of 1850, that the quantity of moisture evaporated from the surface or absorbed by vegetation was "almost constant," viz., from 15 to 20 inches.

Mr. Dickinson, the paper-maker, showed by a guage buried in an open stratum three feet deep, that 57.6 per cent. did not penetrate to that depth, and therefore was evaporated or absorbed by vegetation, and that the remainder (42·4) passed into the guage. This record has a peculiar interest, because it was upon its truth that Mr. Dickinson based his contracts for the making and supply of paper. The tabular statement published by his authority I have reduced to a section, in order to show distinctly the proportion which was lost, and that which became useful to the observant Mr. Dickinson.

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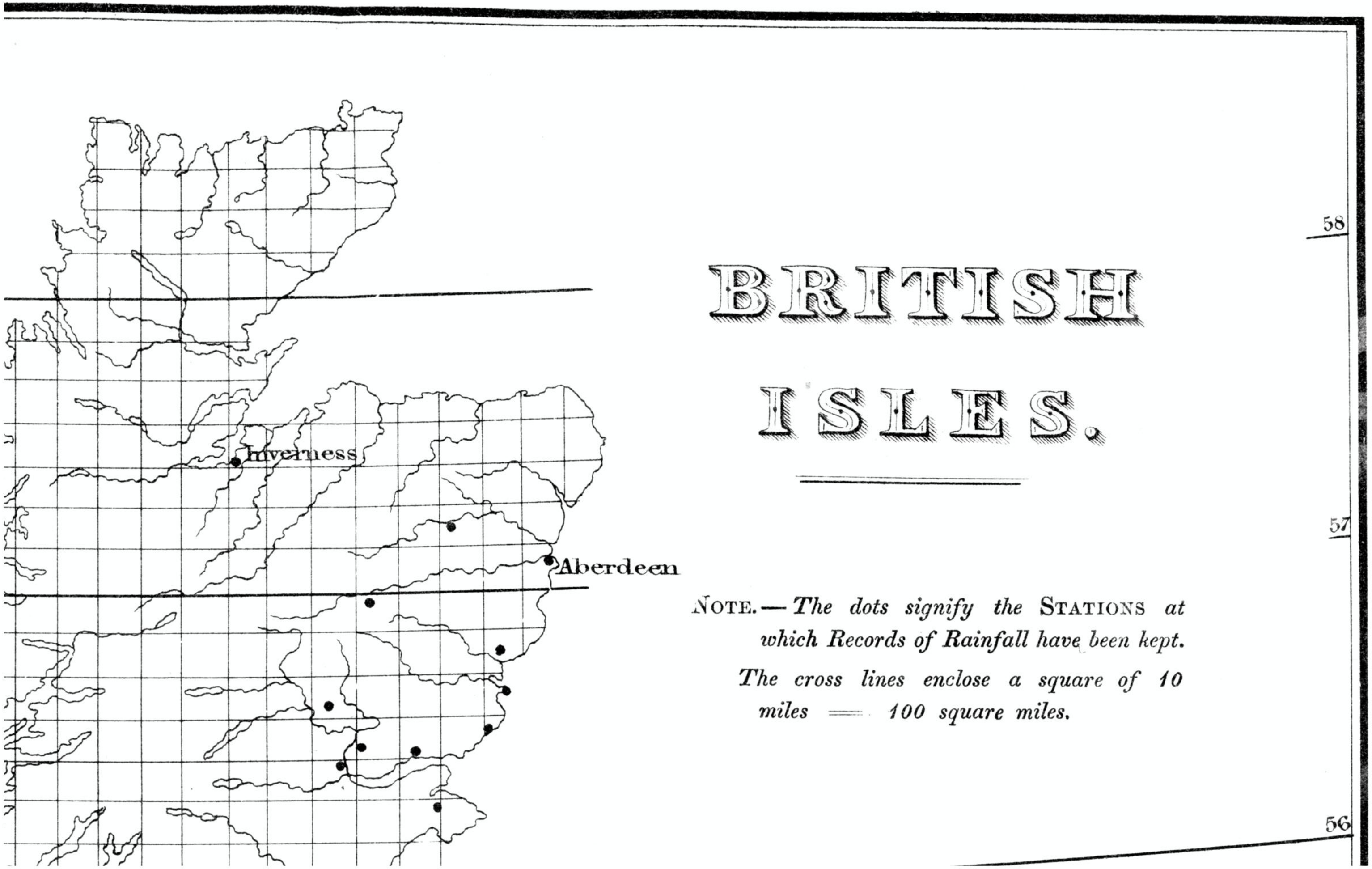
[*] See the admirable articles of Mr. Whitley, in the *Journal R. Agri. Soc.*, and of Mr. Russell, in the *Cyclo. of Agriculture.*

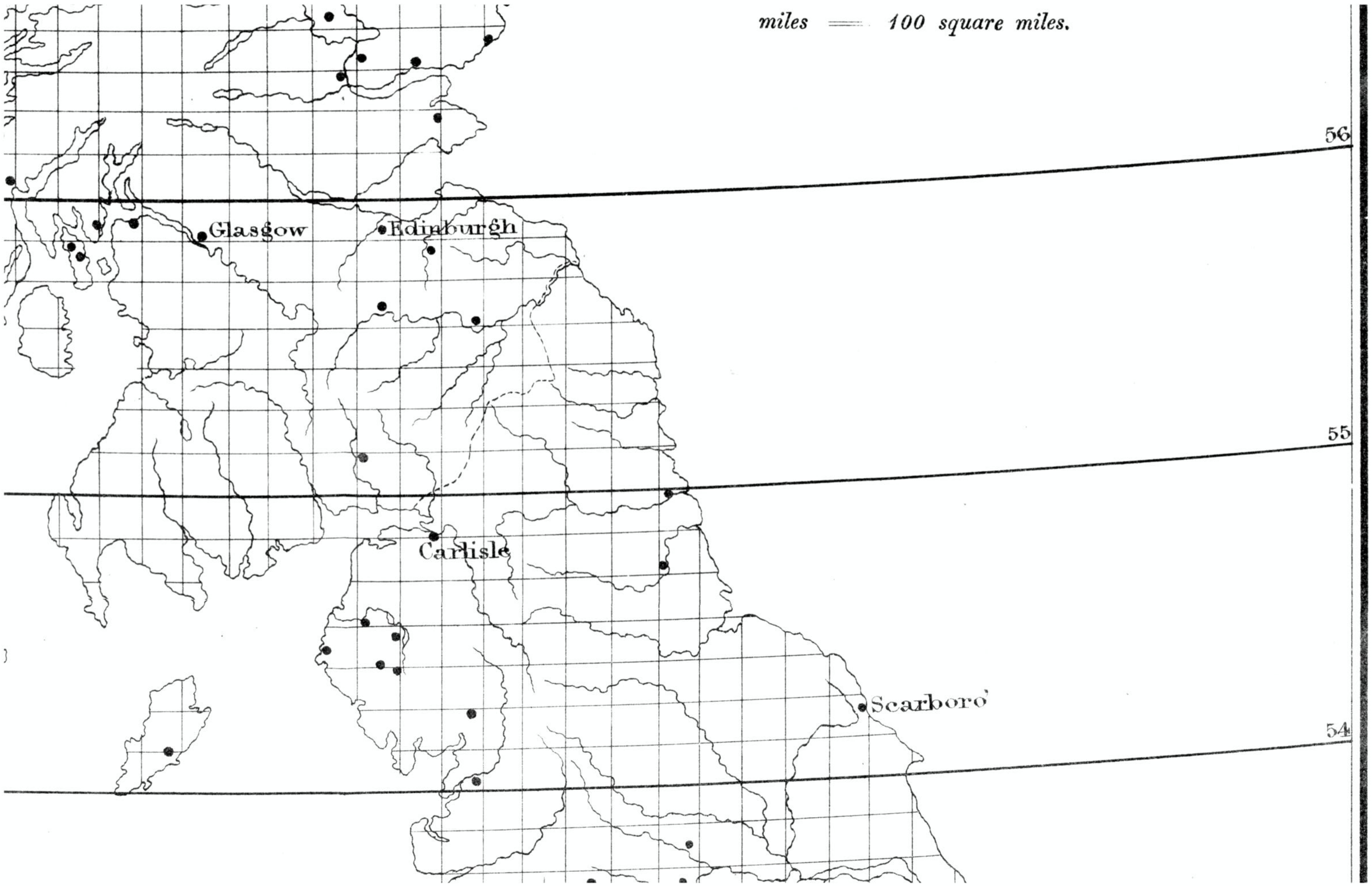
[*] It was Arthur Young who stated that the humidity was "better marked by the hygrometer than the rain-guage." This was said 80 years back. Have we advanced much in practical deductions since?



BRITISH ISLES.

NOTE.—*The dots signify the* STATIONS *at which Records of Rainfall have been kept.*

The cross lines enclose a square of 10 miles = *100 square miles.*


miles = 100 square miles.
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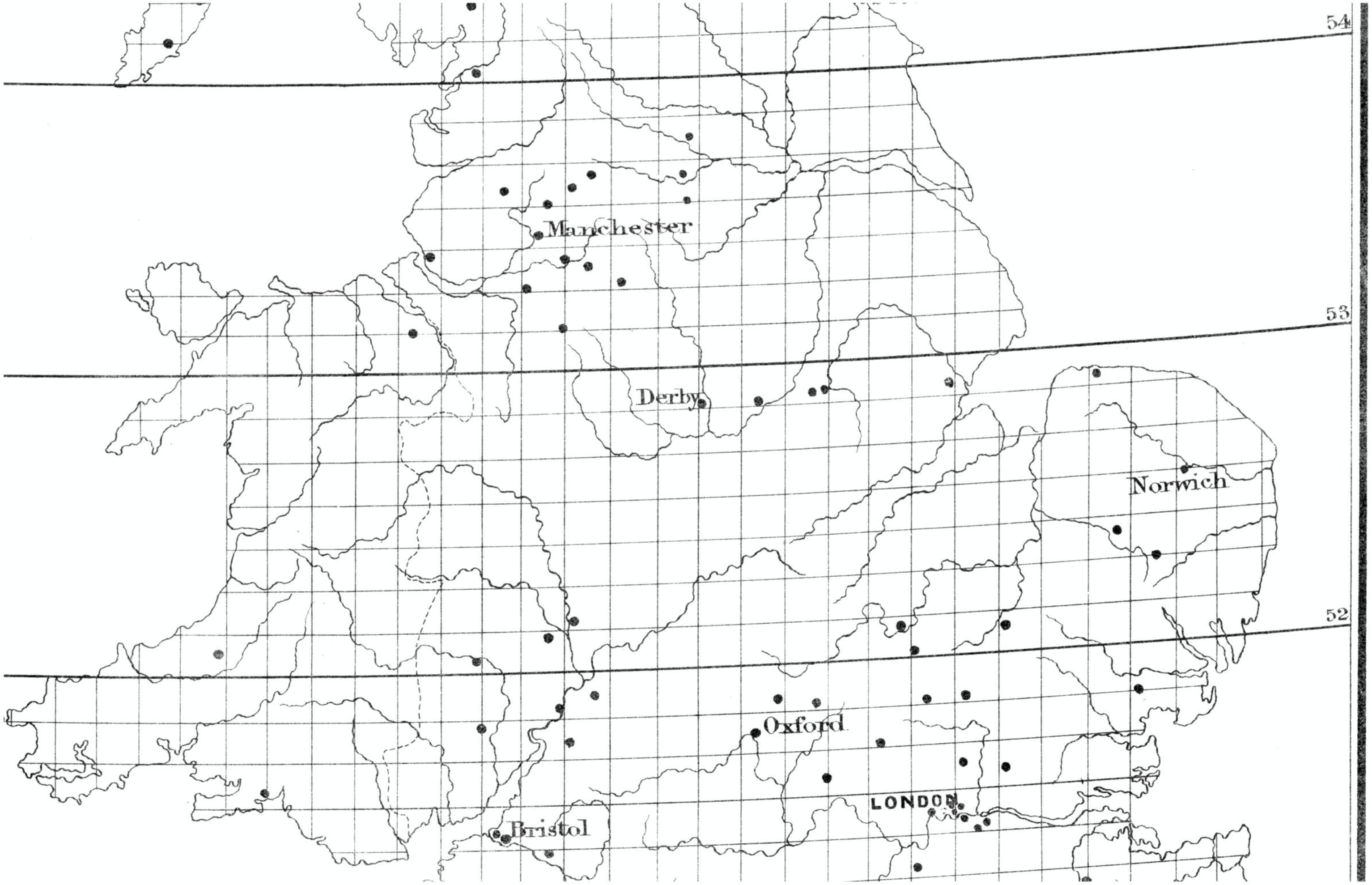
55
54
Glasgow
Edinburgh
Carlisle
Scarboro'



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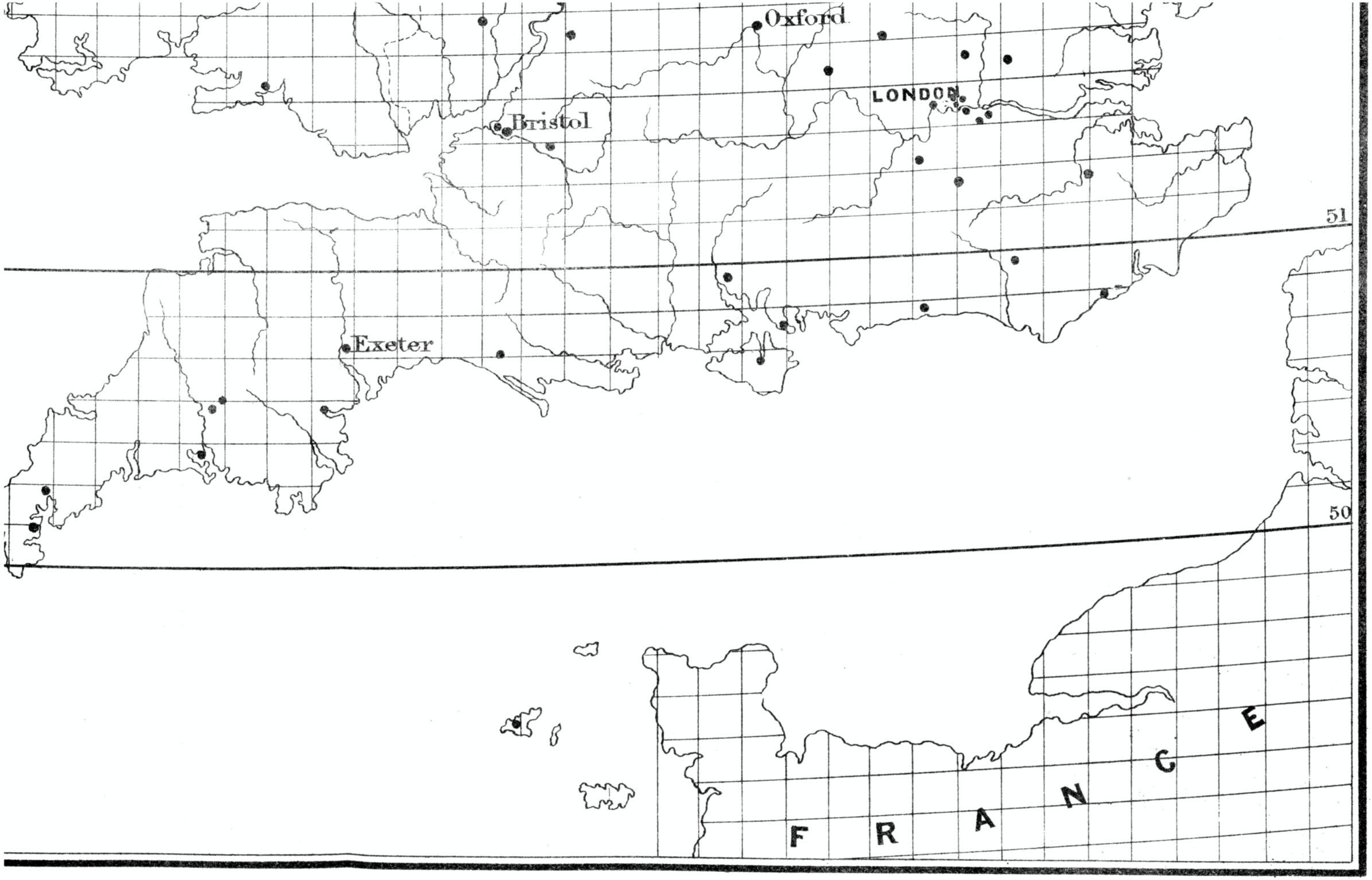
53
52
Manchester
Derby
Norwich
Oxford
LONDON
Bristol


Oxford
LONDON
Bristol
Exeter
51
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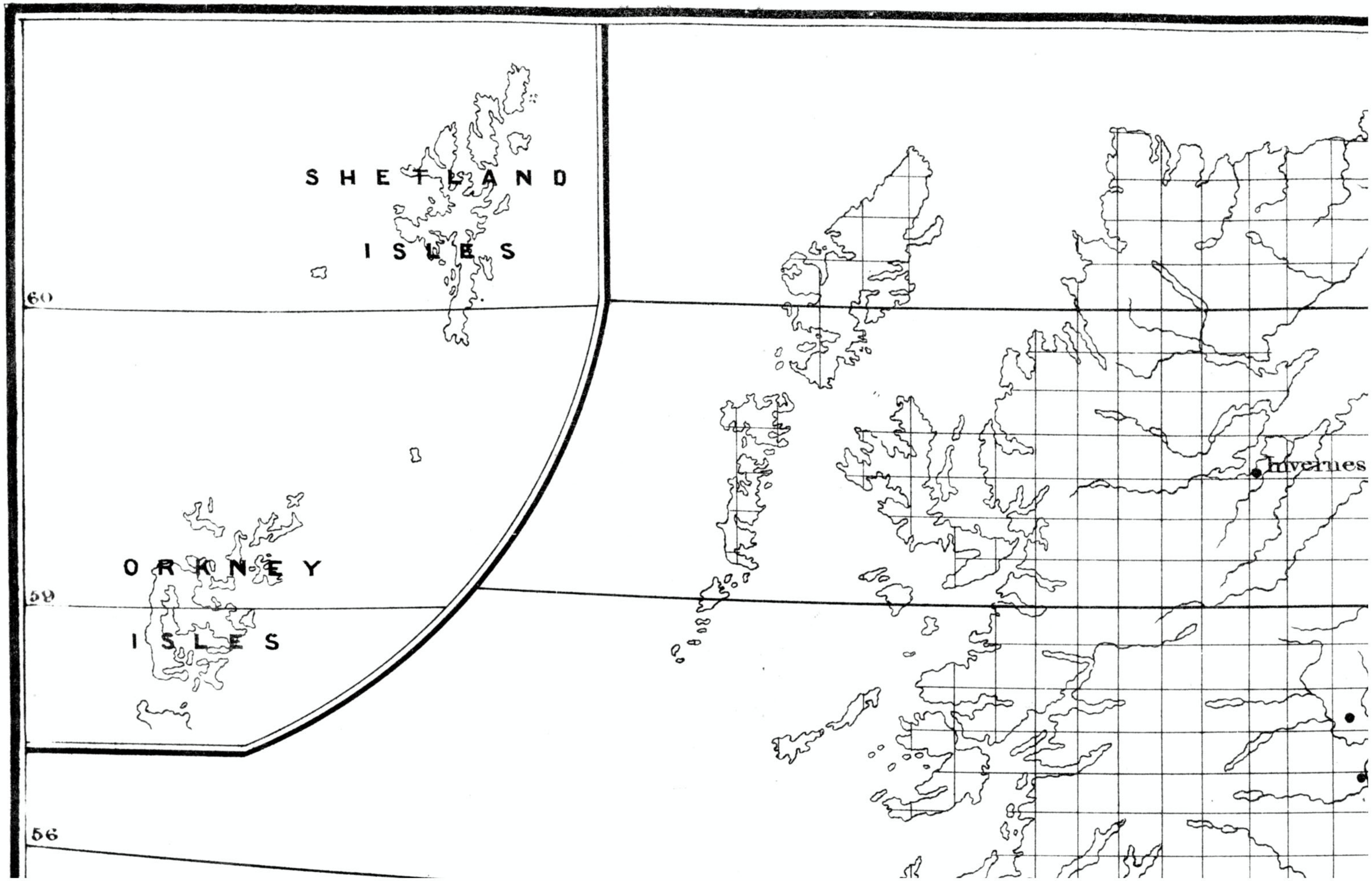
FRANCE


SHETLAND
ISLES
ORKNEY
ISLES
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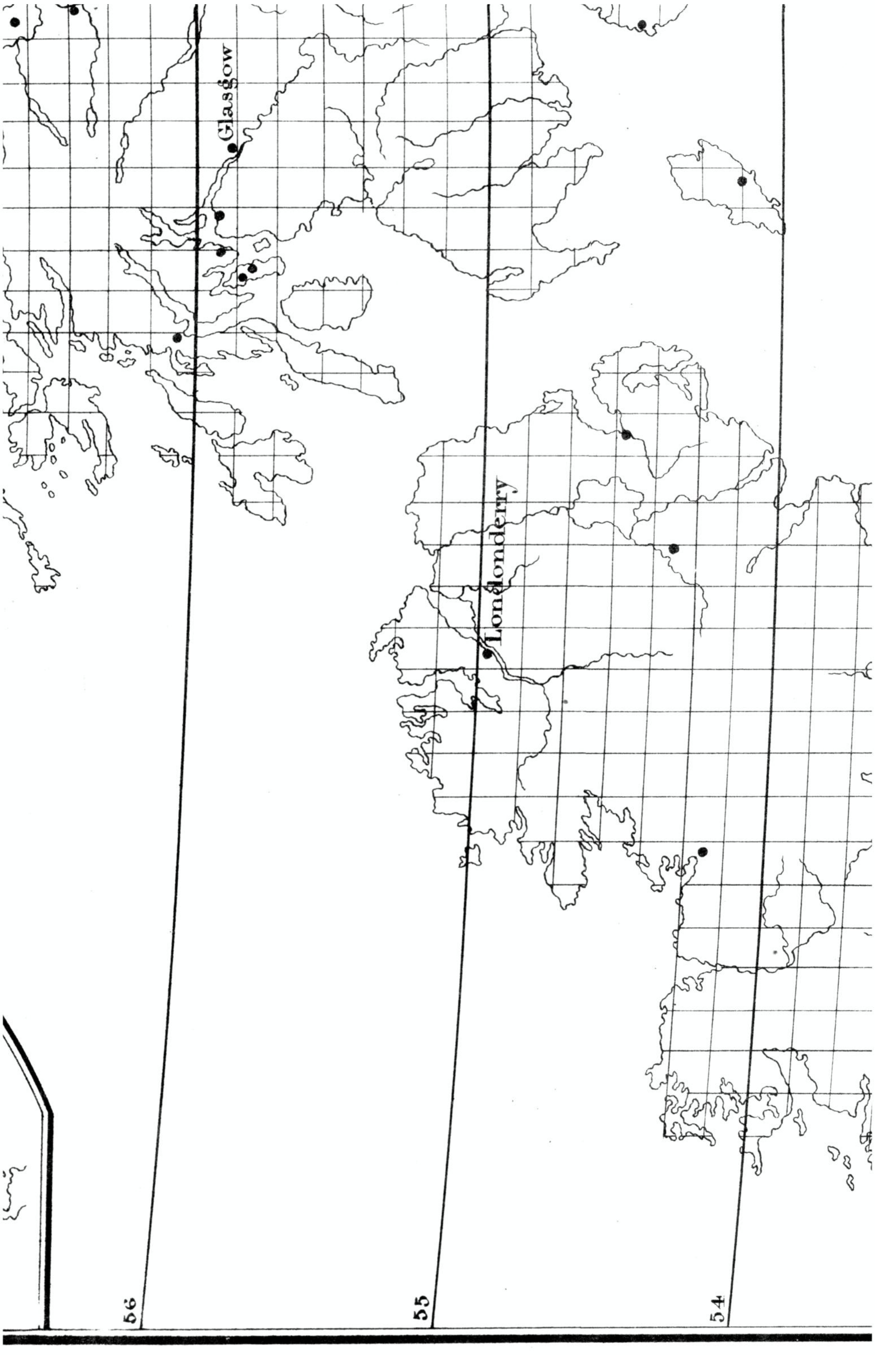
Glasgow
Londonderry
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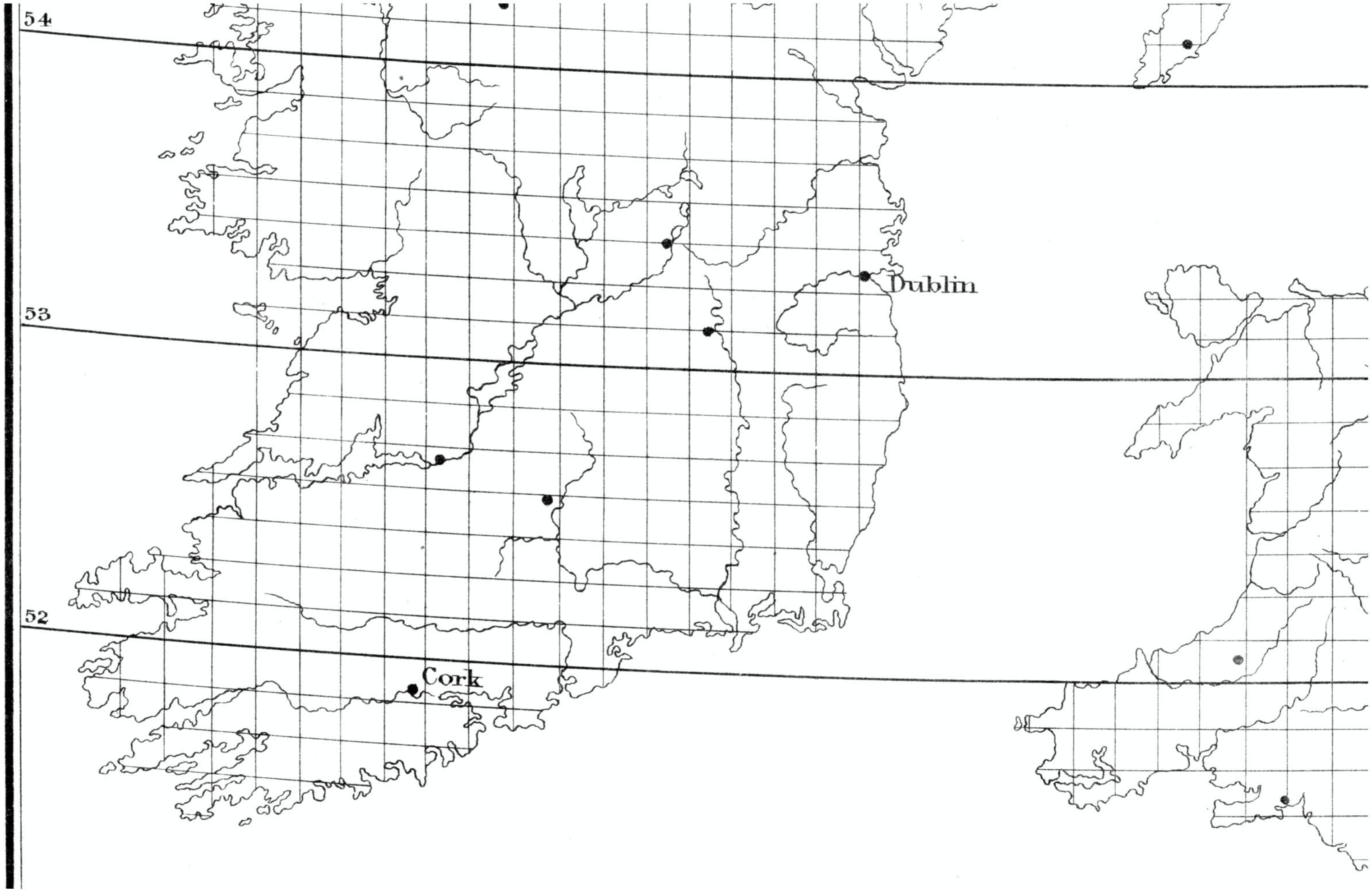
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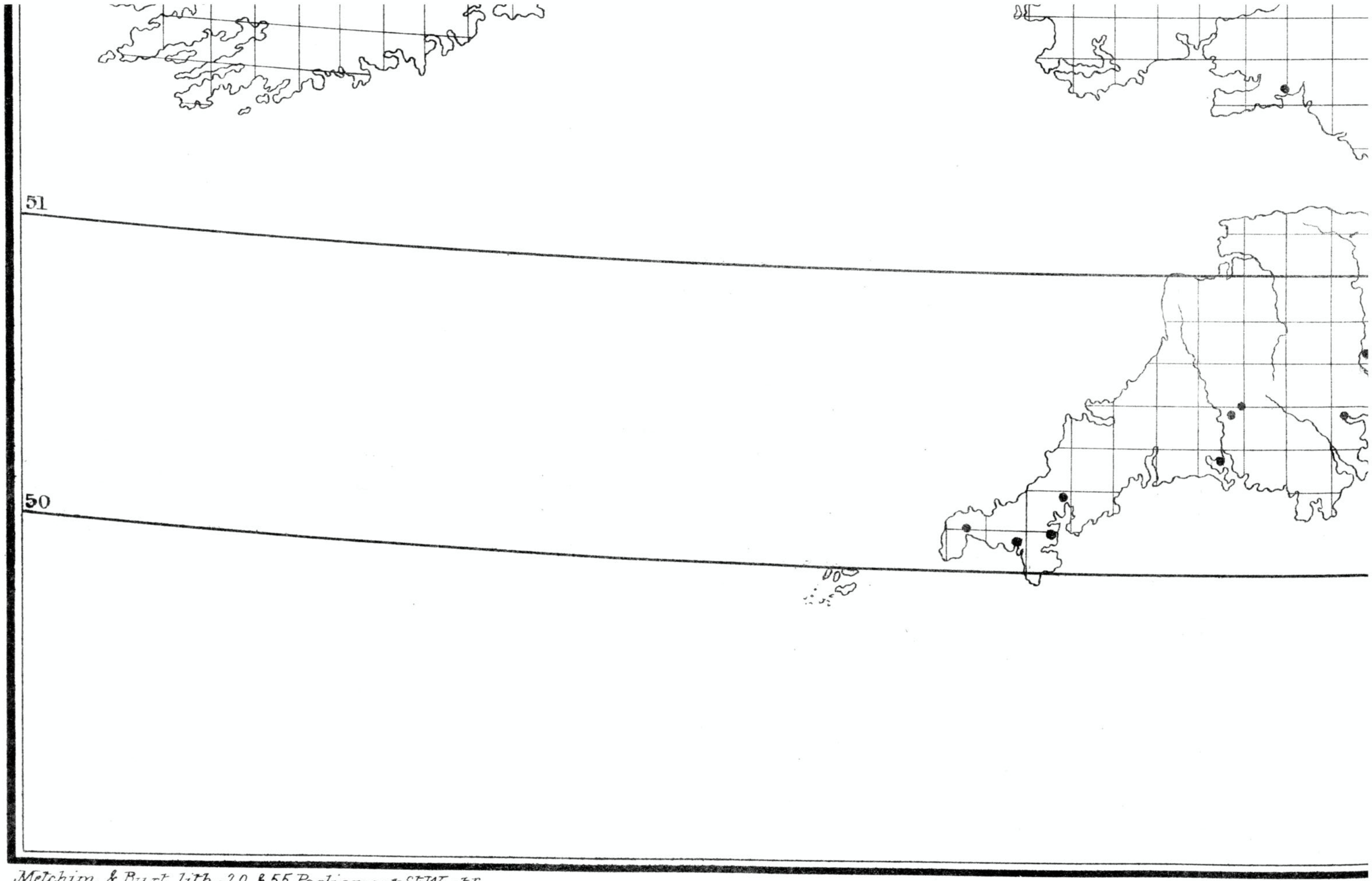
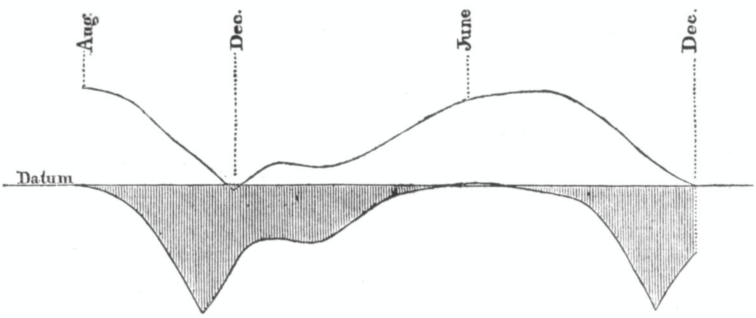
Dublin
Cork



Metchim & Burt, lith: 20 & 55, Parliament St. Westr.



Explanation.—The datum line separates the water that percolated into the lower regions of the earth, and supplied the rivers upon which Mr. Dickinson's mills were situated, from that which re ascended by evaporation, or was appropriated by vegetation, and therefore lost to Mr. Dickinson.

The experiments made by me at Hinxworth (see Appendix), from 1st October, 1856 to 31st May, 1857, *i.e.*, from the time the drainage executed there began to discharge water to the time the drains ceased to run, show that the quantity of rain which percolated the soil, and was discharged by the under-drains, was very much greater in the open (water-bearing) strata than in the clay soils. I found that although the clays discharged a larger proportion of heavy downfalls within the first 24 hours than the open soils, the latter actually discharged in the aggregate nearly seven-tenths of the rain that fell in the eight months, while the former did not disgorge much more than one-fourth of the rain that fell upon them, although no portion was seen to pass off the surface. The well-known retentive property of clays is clearly exhibited by this remarkable difference; and if the quantity of water discharged by the drains can be taken *as indicative of the quantity of evaporation prevented or diminished*, the difference would appear to destroy the assumption of the Board of Health (1850), that evaporation "is constant."*

Such are the conflicting opinions as to evaporation, but I do not propose to go further into the wide, though very important, topics of climate and its influence on animal and vegetable life, but to confine myself to those practical questions connected with engineering, with which I feel myself better qualified to deal.

It has been in the furtherance of the very important works of agricultural drainage and town sewerage that several millions of public money, and borrowed money to be repaid by local rent-charges, have been expended. The Inclosure and Drainage Commissions have governed the expenditure in the one case, and the Health of Towns Commission that in the other. For eleven years and more, public money has been expended, in the first instance in Ireland, and subsequently in England and Scotland, without any effort to supply the desideratum, which I hope to show is so manifestly essential to economy and efficacy in all works designed for the removal or utilisation of surface water.

I have tabulated all the returns I could collect of an authoritative kind, with the kind assistance of Mr. White, of Camberwell, and they are given in the following schedule. To render the amount of information we possess as clear as possible, and to show how little that information is, I have marked the site of each station on a map of the British Isles, over which lines are ruled, latitudinally and longitudinally, at intervals of ten miles, so that the eye may judge, comparatively, of the wide spaces upon which no records have been kept. Each square encloses 100 square miles.

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* The conservative character of clay soils is well expressed in the following old distich:—

"When the clay shall feed the sand,
Then it's good for old England;
But when the sand feeds the clay,
Then she cries, 'Oh! lack-a-day.'"

TABLE OF RAINFALL, SHEWING THE STATIONS IN THE BRITISH ISLES RECOGNISED AS DULY AUTHORITATIVE.

Latitude.		Name of Station.	Rainfall.	Authority or Observer.
Deg.	Min.	ENGLAND.		
50	05	Helston	36·80	Registrar-General.
50	07	Penzance	44·70	*Philosophical Magazine*, Whitley.
50	10	Falmouth	43·7	Royal Institution of Cornwall.
50	14	Truro	33·53	Registrar-General, Whitley, and Allnutt.
50	30	Teignmouth		Registrar-General.
50	30	Tavistock	53·6	Whitley.
50	30	Goodamoor Dartmoor	57·5	Whitley.
50	41	Little Bridy	38·70	Mr. Eaton, M.B.M.S.; Registrar-General.
50	42	Exeter	32·58	Royal Institution of Cornwall, Whitley, Allnutt.
50	45	Gosport	31·07	Simmonds. (Burney, 29.5)
50	47	Worthing		Registrar-General.
50	52	Hastings	28·00	Milner.
50	54	Southampton	29·83	Lieut.-Colonel James (two years), Allnutt.
50	58	Uckfield	28·70	Allnutt.
51	16	Cobham	25·46	Royal Institution.
51	16	Maidstone	21·29	Mr. Fielding (two years), Allnutt.
51	27	Bristol	29·2	Prout, Whitley. (Allnutt, 30·12)
—	—	Clifton (near)		Registrar-General.
51	29	Chiswick	24·8	Howard.
51	28	Lewisham		Mr. Glaisher.

TABLE OF RAINFALL (Continued.)

Latitude.		Name of Station.	Rainfall.	Authority or Observer.
Deg.	Min.			
51	29	Greenwich	21·37	Royal Observatory.
—		London	22·2	Daniel.
51	30	Camberwell	24·65	Mr. W. H. White, late Secretary to the Meteorological Society.
51	33	Upminster	19·50	*Penny Cyclopædia.*
51	36	Swansea	36·60	Jenkins, Whitley.
51	39	Enfield	22·50	Mr. Heath (four years), Registrar-General.
51	40	Epping	26·39	Royal Institution.
51	43	Stroud		*Cyclopædia of Agriculture.*
51	45	Hartwell		Registrar-General.
51	47	Aylesbury	21·00	Milner.
51	45	Great Berkhampstead	29·14	Mr. Squire, M.B.M.S.; Registrar General.
51	46	Oxford	24·06 27·74 22·00	Allnutt. Mr. Johnson, Registrar-General. Milner.
51	50	Gloucester		Registrar-General.
51	50	Monmouth	30·00	
51	54	Cheltenham	25·25	Mr. Moss.
51	54	Bicester		Registrar-General.
52	03	Royston	26·00	Mr. Wortham, M.B.M.S.
52	04	Hereford		
52	07	Cardington		Registrar-General.
52	08	Lampeter	36·69	Rev. S. Matthews, M.A. (Allnutt.)
52	08	Bedford	27·	Milner.
52	12	Worcester	26·35	(?) (Two years only) Allnutt, Registrar-General.
52	13	Cambridge	20·00	Milner.
52	17	Thwaite	23·27	*Cyclopædia of Agriculture.*
52	25	Thetford	19·00	Milner.
52	37	Norwich	22·55	(?) Whitley, 25·5.
52	54	Grantham, Belvoir Castle	24·03	Registrar General, Mr. Ingram (3 years).
52	56	Nottingham	25·08	Mr. Lowe, Registrar-General.
52	57	Holkham	27·44	Mr. Shillabear, Registrar-General.
52	58	Derby	27·	Milner, Registrar-General.
53	00	Boston	24·90	*Philosophical Magazine*, Whitley.
53	10	Hawarden	23·42	Allnutt (two years), Registrar-General.
53	20	Knutsford	23·36	*Philosophical Magazine.*
53	25	Liverpool	36·18	(?) Natural History Society (4 years)—(*Journal of Science*, 34·1.) Registrar-General.
53	29	Manchester	36·14	*Farmers' Encyclopædia.*
53	29	Marple	36·56	It is believed that the staff-guage may have been used for ascertaining the fall in these places; and the staff-guage is not to be relied upon.
53	29	Chapel-le-frith	42·98	
53	30	Bolton	46·74	
53	31	Bury	41·72	
53	31	Rochdale	46·75	
53	31	Blackstone Edge	36·29	
53	31	Fairfield	34·84	
53	39	Ackworth	26·	*Philosophical Magazine.*
53	42	Wakefield		Registrar-General.
53	45	Leeds	20·04	Mr. Denny (four years), Registrar-General.
53	58	York		Registrar-General.
54	17	Scarboro'	22·89	Registrar-General, Mr. Barrington Cooke.
54	21	Kendal	58·00	*Journal of Science.*
54	25	Seathwaite	146·40	Royal Society.
54	30	Gatesgarth	121·40	Royal Society.
54	33	Keswick	63·60	Royal Society.
54	33	Whitehaven	47·10	Royal Society.
54	37	Cockermouth	48·50	Royal Society.
54	46	Durham	30·56	Registrar-General.
54	53	Carlisle	30·55	Simmonds.
55	01	North Shields	25·00	Milner, Registrar-General.
—		Bywell		Registrar-General.
		IRELAND.		
51	55	Cork	36·03	Royal Institution. (40·20, another observer.)
52	29	Limerick	35·00	Mr. Peterman.
52	35	Toomevara	40·50	Whitley.
53	10	Portarlington	27·15	Dr. Hemlow (two years only)
53	20	Dublin	24·60	Trinity College.
53	42	Edgeworth-town		Transactions of Irish Academy, Whitley.
54	10	Coloony	42·00	Whitley.

TABLE OF RAINFALL (Continued).

Latitude. Deg.	Latitude. Min.	Name of Station.	Rainfall.	Authority or Observer.
54	21	Armagh	25·26	Dr. Robinson (two years).
54	36	Belfast	27·49	Queen's College. (30 to 39½, say Belfast Society for Promoting Knowledge)
55	00	Londonderry	——	Transactions of Irish Academy.
		SCOTLAND.		
55	13	Applegarth Manse	33·60	*Philosophical Magazine.*
55	34	Makerstun	24·32	Mr. Hogg (two years only).
55	50	Glasgow	30·00	McCulloch, Whitley.
		Carbeth	42·50	Ditto.
55	51	Rothesay	38·50	*Cyclopædia of Agriculture.*
——		Mount Steward	46·60	Whitley.
55	54	Annatt		
55	55	Dalkeith	22·00	McCulloch.
55	57	Greenock	40·00	Milner.
55	58	Dunoon	56·00	Ditto.
55	58	Edinburgh	24·00	Professor Johnson, Simmonds.
56	00	Peebles	28·70	Milner, McCulloch.
56	04	Lochiel's Head	37·00	Mr. Malcolm (two years.
56	10	Kinfauns Castle	25·60	140 feet above sea.—Whitley.
——		Hill near	41·50	600 feet above sea.—Whitley.
56	29	Dundee	22·00	McCulloch.
57	09	Aberdeen	23·30	Simmonds.
57	16	Clunie	25·00	Milner.
57	18	Alford	37·90	*Edinburgh Philosophical Journal.*
57	28	Inverness	26·00	Milner.
		ISLANDS.		
49	12	Jersey		
49	33	Guernsey		Registrar-General.
		Ventnor ...		Registrar-General.
50	42	Newport... } Isle of Wight...	29·80	Mr. Bloxam (two years).
		Ryde		Registrar-General.
54	10	Isle of Man	36·25	*Journal of Science.*
58	12	Lewis	30·06	Sir James Matheson, Bart. (two years).
59	00	Orkney	36·83	*Philosophical Magazine.*

Note.—These Stations have been selected as those which are deservedly authoritative. They have been selected from standard publications only. Most interesting and valuable information is given in the reports of Mr. Homersham as to the relative effect of *height of station*, using the same guage, with precisely the same treatment in every other respect.

Although the agriculturist, the engineer, and the physician will be unable to apply practically the information this schedule gives, the curious in matters of science will be struck with the following facts:—1st. That the rainfall in one district is more than seven times that of another; 2nd. That the difference of rainfall at one point, compared with another, is as much as 127 inches; 3rd. That the rainfall on the western side of England ranges from 30 to 51 inches, while that on the south-eastern side ranges from 16 to 24 inches; hence the "mean" of the one is double that of the other [*See also McCulloch*]; 4th. That the rainfall on the western extreme (Penzance) is 44·70, while that on the eastern (Thwaite, in Suffolk) is 23·27; 5th. That comparing places, of the same degree of latitude, the rainfall at Manchester (lat. 53 deg., 27 min.) is 36·14; at Nottingham (lat. 52 deg., 57 min.), 25·08; and at Boston (lat. 53 deg.), 24·90; 6th. That the rainfall in the Isle of Man (lat. 54 deg., 15 min.) is 36·25; at Kendal (lat. 54 deg. 21 min.) is 58 inches, and at Scarboro' (lat. 54 deg. 17 min.) 22·89; 7th. That comparing places on the same geological formation, *i.e.*, with soils very possibly the same mechanically and chemically, the following differences will appear. Take the old red sandstone, which is found in South Devon, in Monmouthshire, and Buteshire in Scotland; the rainfall at Dartmoor (Goodamoor) is 57½ inches; at Monmouth 30 inches; and at Mount Stewart 46½. On the lias, with its close clay,—which crops out in Dorsetshire, and extends to the north of Yorkshire, taking Grantham in its course—the rainfall at Little Bridy is 38·70; at Grantham 24 inches; and at Scarboro' 22·89. Or if we come nearer home, on to the outskirts of the London basin, we find, at Cambridge and Thetford, the rainfall is less than 20 inches; at Gosport and Hastings nearly 29 inches; and in London, midway between the escarpments, it is 22·2 (Daniel).

Having shown, as far as I am able, the amount of information which at present stands on record, it remains to be exhibited how a perfect system of registration might be made available in the hands of the engineer for a better mode of under drainage, improved means of arterial drainage, and the profitable application of drainage and surface waters.

1. *Under Drainage and Sewerage.*—As the removal of surplus surface water is the primary object of agricultural drainage, and as the rain falling on the surface of town districts is the main obstacle with which engineers have to contend in designing the sewerage of towns, it can hardly be necessary to show that the very first question to be solved should be the amount of rainfall peculiar to each locality.

This assertion in respect to the under-draining of land has been always met by the statement that the drains used are so numerous in the aggregate, and so much more capacious than can be required under any circumstances, that it is an unnecessary refinement in the application of science to inquire into the quantity of rain the pipes are to carry, or to burden the proceedings by calculations of their dimensions. I am bound, however, to record my own conviction, based on an extensive practice in the drainage of land, that there is no information more essential to successful treatment than that which it is the object of this paper to promote, and that it is the ignorance now prevailing with regard to the influence of the rainfall, added to the common belief that drainage is a mechanical operation which an uneducated bailiff or woodman may carry out, that has led to the discredit attached to the drainage executed under government auspices, and has fostered the opposition of certain members of the Central Farmers' Club. As a proof of how little attention landowners have hitherto paid to rainfall, I may mention that when I undertook to read a paper, three years back, before the Central Farmers' Club, on the results of under draining in Great Britain, I addressed more than 300 persons in various parts of Great Britain, who had executed works of under draining, and asked the following question among several others,—"What is the rainfall in the locality of your works?" I was gratified by receiving 162 answers to my letters, but out of 162 answers there were only six who were able to give me any information as to the rainfall.

No doubt this prevailing inattention has arisen from, and the arguments used against the utility of a knowledge of rainfall have been supported by, the fact that when we aim at draining tenacious clay lands, we can only fully attain the object by a multitude of conduits, which serve not only to remove the maximum quantity of water reaching them, but to aërate the soil whereby their natural retentiveness (which is three times as great as sandy soils) is overcome and percolation facilitated.

In the drainage of open soils, *i.e.*, the water bearing strata, which alternate with the retentive and so-called non-porous strata from one end of the kingdom to the other, there is no such two-fold object by which to excuse an excess of outlay; and the quantity of water to be removed is the measure of the size of pipes, the number of the drains, and the mode of draining to be adopted. Every drain in excess of what will effect this single purpose is positive waste, whereas in clay soils, uniform aëration and disintegration being points of equal importance with the removal of surplus water itself it is hardly possible to increase the number of drains without producing some benefit. To relieve the open water-bearing strata of the excess of water which presses from the higher to the lower levels, three inquiries are essential to economy and success. 1. The quantity of rain falling in the district. 2. The extent and altitude of the contributing area, and 3. The nature and position of the impounding substratum. To show how much at fault we are at this moment in our treatment of the open soils of different formation, which, for the most part, would be equally susceptible of percolation if channels of discharge were provided below, it may be mentioned, that the silicious beds of the crag in Suffolk, where the rainfall does not reach 20 inches, are being drained in a very similar manner to the valleys composed of drift and debris of the primary and transition rocks in Westmoreland and Cumberland, where the rainfall is 50 inches, and where a maximum fall has been recorded of 31 inches in a single month, equal, in fact, to 18 months' rain in Suffolk. (*See Miller, on the New Philosophical Journal of Edinburgh*, 1853.)

In acknowledging that in clay soils the number of drains usually adopted for thorough drainage are at all times sufficient, when properly connected with full-sized main drains, to carry off any possible fall of rain, it should be understood that in order to produce that perfect amelioration to which I have referred, the number of drains should be multiplied beyond the quantity required for removal of water in proportion to the quantity of rain falling upon the surface and the prevalence of humidity. To appreciate this position, it should be remembered that Sir Humphrey Davy showed that stiff clays will absorb from the atmosphere alone 1-30th of their own weight in a single night. With absorption comes expansion, and to such extent that the difference in size between the same clays, wet and dry, will sometimes reach one-fifth (Johnstone). Hence, resistance and their incapacity to admit water to pass through them as rapidly as other soils.

Having stated that it is the omission of such considerations as these, and the provisions which the difference in rainfall should suggest that has led to dissatisfaction and encouraged opposition to permanent works of drainage, I am bound to give evidence of the fact. In the west of England, where the annual fall of rain is 50 inches, some drainage was effected by a parallel system 40 feet apart. It was pronounced a failure. It has been compared with other works of drainage which were satisfactory in result upon the same geological formation (with soils closely similar in character), drained in the same way, on the east side of Scotland. The rainfall there was 25 inches, and the number of wet days considerably less than in the West of England, and it is more than probable that these differences account for the results. Another instance will render the proposition even more clear. The lias clay, as already stated, runs nearly the whole length of England. It starts from Lyme Regis, where the fall of rain is 37 inches, passes by Grantham, where the fall is 24 inches, and runs out at the north-east corner of Yorkshire, where the fall is 21 inches. Lands of this clay (as similar as soils can be) have been drained in the several localities in a precisely similar manner with different degrees of effect. The difference in the rainfall can alone explain the difference of effect. Sixteen inches of rain, which is the difference between the two extremes, is equal to 362,000 gallons falling upon every acre of land, and this excess is nearly equal to the whole annual amount of rain falling on the surface of Essex and Suffolk, in which counties many thousands of acres of clay lands, no stronger than the lias, are now being drained at a cost of from £5 to £6 per acre. This is a striking fact, but it will be rendered still more striking by reference to the Registrar-General's Return for the first three months of the year just closed. There it will be seen that the rainfall, for that period at the three places named, was respectively 9 inches (Little Bridy), 6 inches (Grantham), and three inches (Scarborough). Hence it follows that the drains in Dorset would be required to do three times the work of drains in Yorkshire with the same means of doing it.

Time will not allow of my multiplying instances in which a knowledge of the rainfall would lead to a more profitable and satisfactory treatment of under drainage. With clay equally tenacious, but affected differently by the amount of rain falling upon their surface, it would not be difficult to expose, by a multiplicity of facts, the inconsistency of which we are daily guilty, and the many causes we have given for failure.

And if we turn from land drainage to town sewerage, we discover the same want of information and similar evils resulting from ignorance. To dispose of the rain-water falling on the surface of town districts, without increasing the cost of the sewerage works beyond reasonable limits, is often the problem which defeats progress, and as we have frequently no reliable records of the quantity of rain falling on the surface, the difficulty of solving it is increased. It is so with respect to the metropolis at the present moment, and the metropolis is only a magnified type of all other towns in respect to the principles which should govern works of sewerage.

2. I will now pass to *Arterial Drainage*. It cannot be many years ere this important branch of engineering forces itself on public attention, for reasons which have a direct bearing on the subject of this paper. The circumstances to which I refer, are, 1st, the growing spirit of improvement which will shortly demand the underdraining of the valley lands, now incapable of being

drained at an adequate depth for want of effective outfall; 2ndly, the incapacity of numerous rivers and streams to receive and discharge the increasing quantity of water thrown into them by the underdrainage of the water-bearing strata and beds; and, 3rdly, the sudden discharge of water from the underdrains of clay lands immediately after heavy falls of rain.

The test of all underdrainage is the depth of free soil through which water will pass to the drains. In an open soil, a few drains will suffice to keep down the level of standing water as effectually as the numerous drains of the clays. But the amount by which evaporation is diminished by drainage must be very different in the two descriptions of land. In the open water-bearing soils, the amount of evaporation must be greatly diminished by underdrainage; in the clays it would appear to be very little affected. Under any circumstances, it may be assumed that whatever the amount of water arrested from the atmosphere by underdraining, that quantity is discharged to the sea by the main and tributary outfalls in excess of what was discharged previously.

At Hinxworth, (see Appendix) the occasional drains by which the open mixed soils (see Mr. Way's analysis in Appendix) were relieved of excessive wetness were frequently 75 yards asunder, and from 4 to 7 feet deep. Before draining the open soils, the subterranean water level, following the universal law, gradually rose to the surface as it was replenished by the winter's rains, corroborative of the old Wiltshire saying, "As the days lengthen so the springs strengthen." The water that so rose to the surface found escape by excessive evaporation in the months of March, April, and May, and by oozing from the lowest grounds in the nature of springs, which declined in height as the summer advanced, and as the subterranean water level declined. After draining, the quantity of water discharged by the underdrains from these open soils during the period they were running, was 160,920 gallons per acre, out of 227,240 gallons which the rain guage showed fell upon every acre of surface, and it is fair to assume that the greater part, if not the whole, of this large quantity of water was that which would have been dissipated by evaporation if the land had not been drained (See Johnstone's Elements of Agricultural Chemistry, pp. 124, 125), for it does not appear that the supply to the rivers has been in any way affected in the summer season. These open lands were discharging, throughout the greater part of January and February, when evaporation is very trifling, above 1000 gallons per acre per diem of that water which would have remained in the soil until the east winds of early spring and the influence of the sun in May and June had converted it into vapour at the expense of vegetation. When this quantity is multiplied by the number of acres of similar land drained and to be drained in these islands, the quantity of *new* water which has to find its way into the outfall streams will be appreciated.

Referring again to the Hinxworth records, we find a very different result with respect to the clay lands, which were drained uniformly 4 feet deep, 25 feet apart (see Mr. Way's analysis). The quantity discharged by the numerous underdrains while they were running, was 59,936 gallons per acre, leaving 167,384 gallons in the soil to be lost by evaporation and appropriated by vegetation. Before draining these clay lands, that portion which the soil could not absorb either flowed off the surface to the outfalls, or remained on it to be evaporated. After draining, the rain-fall penetrated to the depth of the drains, and when once the Autumn rains had completely replenished the absorbent demands of the soil, and the two powers of gravitation and attraction had struck a balance, a large proportion of any succeeding rain was immediately discharged by the underdrains. There was a fall of rain at Hinxworth in October, 1856, of 1·645, and in November of 1·630, equal together to a supply to the soil of 74,087 gallons, or 330 tons of water per acre. The drains just began to trickle on the 27th of November, after a fall of half an inch of rain (·540). The test holes in the land showed that the soil was rapidly feeding itself and that the water level was rising, but had not reached the level of the drains. On the 12th December, the outlets were running 160 gallons per diem per acre after frequent rains in the early part of the month of less than a tenth of an inch per diem. On the 13th, the rain guage showed a fall of ·452 (nearly half an inch) and the outlets increased their discharge from 160 gallons to 975 gallons per diem per acre. On the 9th January, 1857, the outlets were running 125 gallons per diem. On the 10th, the rain guage showed a fall of ·542 (rather more than half an inch), and the discharge from the outlets was increased from 125 gallons to 5,150 gallons per diem per acre. How important are these facts in considering the effect of extended underdrainage on the arterial channels of the country, and how necessary a knowledge of the rainfall in providing for it. The Hinxworth records show that the clay lands which prejudice had declared impenetrable, were discharging after heavy rains in the wet season a greater quantity of water per acre than the open soils, and much more than it is believed would have flowed off the surface before the land was drained.

Before quitting the subject of arterial drainage, there appears to be one other point upon which an accurate knowledge of the amount of rainfall would be of signal service. It is admitted on all hands, that no general improvement of outfalls can take place, without a sacrifice of numerous mills and the water power by which they are worked. If a sacrifice such as this is necessary to obtain a national benefit, is it not our duty to look around and see if there be not within our reach a compensatory amount of power at higher points, which may be made available for use by drainage and conservation.

I do not wish to detract from the attention I hope to secure to the object of this paper, by dwelling upon points which may be deemed problematical, and will, therefore, simply state that every 37½ cubic feet of water which could be collected by drainage and delivered each minute to a 10-foot wheel, represents the power of a horse, and it is obvious that when height becomes so important an element as it does in the calculation of motive power, it is more than probable that the waters which might be collected and supplied at higher levels within the watershed of main valleys, would go far to make up for the loss of power occasioned by the condemnation of mills below. But here, as in other respects, we are in ignorance of the rainfall at command in each locality, and there are no tangible data upon which to base calculations.

3. *Profitable Application of Surface and Drainage Water.*—This part of the subject is a very wide and interesting one, but we can only deal with it cursorily. All rain falling on a surface which from any cause is impermeable, either flows off its sloping surfaces to the outfalls, or rests on its flat or hollow surfaces until evaporation has reclaimed it; and all rain falling on a surface permeable in its natural state, or rendered so by underdraining, either finds its way down to the subterranean water level which feeds the springs at the out-crops, or to the level of the underdrains, which limit the height of stagnant water in all soils.

In each case a considerable portion of the rainfall may be made serviceable to man in some way or other, if quantity, quality, and altitude are favourable for appropriation. The floods which run off the surface may be impounded; the water that rests on the surface may be rescued from evaporation by underdraining; the water that escapes from the water-bearing strata is at all times available; and the water discharged from the underdrains may be concentrated by systematic arrangement.

In every instance, however, a precise knowledge of the rainfall is indispensable, and numberless are the occasions when a want of the knowledge has negatived all efforts to convert the "evil of to-day" into the "benefit of to-morrow."

The various uses to which surface-waters and injurious under-waters discharged by drainage, may be applied, are in supplying towns and villages with water for domestic purposes, in irrigation, and as a motive power for machinery.

The impounding of surface and flood-waters in reservoirs in the higher valleys, has been long adopted in this country. Several towns, and nearly all the principal canals in England and Scotland, obtain their supply by this means of collection. Manchester has executed its works at Longdendale, and Liverpool at Rivington Pike. In Scotland, Edinburgh has done the like,--and Greenock has collected the water of an area of 5,000 acres, from Ducal Moss to Shaw's Hills, which not only supplies the town with water for domestic purposes, but furnishes two lines of mills with a quantity amounting to above 500,000,000 cubic feet annually. These instances, which might be multiplied by others, extending from north to south along the whole range of the earlier geological formations, are only referred to as illustrative of the application of surface-water by impounding in reservoirs, —a mode of conservation which would be extensively adopted for minor objects throughout the country, were the data of rainfall at command. As minor objects, we may point to irrigation and mill power, of which abundant examples already exist,—particularly in the mining districts of the west and the Highland farms of Scotland,—affording admirable instances of the profitable use of surface-water.[*]

The quality of the water supplied from impounding reservoirs, is always inferior to that derived from under-draining, to which the soil becomes a filter, and arrests the impurities which find their way into embanked valleys, and are fostered in open reservoirs. The use of drainage water, therefore, is an object which commends itself to the mind of all who consider it. If applied, as it frequently might be, to the supply of towns and villages, it has all the advantages of filtration, and the flow of the drains is never interrupted by frost so long as there is water in the land to discharge. The temperature of deep drainage water will be found to range from 37° to 40°, when the thermometer shows the temperature of the air to vary from 32° to 16°, or from freezing point to 16° below it. Now this is a point of much moment in considering the application of drainage water in rural villages. How many are the instances in which whole villages are destitute of water, and how frequently could the owner of adjacent lands supply the deficiency by concentrating, at a few pounds extra cost, the water he is throwing away when draining. In irrigation and in the supply of water to farm premises for cattle, or, if quantity favours, to put machinery in motion, the application of the non-freezing drainage water seems peculiarly desirable. At present it is seldom thought of, simply because the amount of rain which constitutes the primary supply is unknown, and because all attention is paid to the removal of the enemy (excess of water) without considering how readily that enemy might be converted into a friend. Moreover, a very large proportion of the under-drainage of this country is executed under the management of bailiffs and woodmen, who, in 9 cases out of 10, are quite incapable of devising a concentrating system of drainage, or who may never have seen a spirit level.

In the case of Lord Hatherton, at Teddesley, we have an admirable instance of the application of drainage water to the two-fold purpose of motive power and irrigation. His lordship drained 467 acres of land at a cost of £1508 17s. 4d., and increased the rental £435 2s. 4d. (nearly 30 per cent.) He erected a water-wheel and machinery, and laid out irrigation at a cost of £1,224 4s. 10d., and gained £578 a year by the outlay. (See article Drainage, in the *Westminster Review*, 1842, by the writer.)

It is no sanguine view to declare that there are thousands of estates in the United Kingdom in which a similar advantage might be gained, as a proof of which, if we turn again to the Hinxworth Records, we shall find that the quantity of water (160,920 gallons per acre) which ran from the open mixed soils during the period of discharge, would supply power equal to one horse for 11 hours 17 minutes for every acre; so that if the discharge of the 400 acres (of the same soil) could be concentrated at one point—and in larger estates there would be no doubt of it—there would be available a power equal to six horses for 125 days. In my own practice, I have already applied the waters discharged from drainage for irrigation, and the tenants have gladly paid the demand of the owner by which the cost with interest has been liquidated.

As to the mode of obtaining, collecting, and publishing returns of the rainfall, several suggestions have been made. By some it was thought that a weekly return from every church clerk, or some other parochial officer, might be obtained; but inasmuch as the majority of church clerks and parochial officers in the rural districts are engaged in farming pursuits, and are oftimes away from home from early in the morning till late in the evening, and are otherwise disqualified by their habits and pursuits for the precise work of daily registration, that idea was soon abandoned. Another proposition was to make the returns of rainfall a branch of agricultural statistics. It is needless to say that, as the bill for the latter object was thrown out of Parliament, that proposal has not been encouraged, though there is no doubt the two objects are so allied as to admit of a useful union.

Up to this time, it would appear that no suggestion has been made which has received general approval. In the suggestions I shall venture to make, I purpose keeping to the simple object of a complete record of the fall of rain, without complicating that inquiry with any other. It is believed that a period of 20 years would suffice to obtain the desired information. Either of the several public bodies to which I have referred, i.e., the several national chartered Agricultural Societies, each for their separate country; or the Inclosure and Drainage Commissioners; or the Board of Health; or the Meteorological Societies; or the Registrar-General; are fully competent to act as a central official body for the collection, arrangement, and publication of returns, if the means for defraying the cost of an additional department were placed at their disposal. One responsible officer, as a registrar of rainfall, would suffice to control the department, and would cost, probably, on the whole, £1,200 to £1,500 a year.

The formation of a base of observations throughout the country and the appointment of competent and reliable observers is not so easily disposed of.

It is admitted on all hands that if the collection of these necessary returns were authorised by Parliament, it would not be advisable to trust wholly to voluntary observers, but that a certain number of paid observers[*] should form the base of information, with a fore-knowledge that the number of voluntary contributors would increase the returns to any amount that might be considered desirable. The question that then arises is, who are the persons who could be relied upon for correct returns, and who would be satisfied with such an annual payment as would meet the views of the country? And what is the least number of stations that would suffice for a base of information? The class or description of persons who, it would appear, are competent and suitable, and who would, most likely, be content with a small return, are the masters of Unions, the masters of National Schools, the clerks at railway stations, and gardeners of superior establishments. And if the observations are confined to the rain-fall, there is no doubt that £5 per annum would be deemed by them an ample return for the trouble of recording and transmitting the returns weekly to the central office. This arrangement would, of course, involve the supply of the necessary rain guage to each observer.

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[*] At the Fowey-Consols mine in Cornwall, the water collected from one hill, is brought home by an aqueduct and delivered to 13 wheels in succession, of an aggregate power of 477 horses. Some interesting papers, elucidating this mode of collecting and applying water, were read before the Institution of Civil Engineers, "On the Bann Reservoirs, County Down, Ireland," and "On the Overshot-wheels at Wheal Friendship Mines, near Tavistock." Some good papers on reservoirs for agricultural purposes, are to be found in the "Journal of the Highland Society of Scotland."

[*] By examining the returns of the Scottish Meteorological Society, it will be seen that the majority of observers are gardeners. Dr. Robinson, of Armagh, informs me that registers were kept at the several coast guard stations in Ireland, under the direction of the Royal Irish Academy, but they have been discontinued since 1851.

It has been stated that if there was one paid station to every square of ten miles, or that if the paid stations were at a minimum distance of ten miles apart, it would suffice for all purposes, but this is not my belief. I consider that the distance between paid stations should not exceed a mean of five miles in the cultivated districts, and that the stations in the uncultivated and unprofitable districts should be fixed as near as circumstances would admit. The total area of the United Kingdom is 122,185 square miles, or 46,522,970 acres cultivated, and 30,871,463 uncultivated acres. If the base of information were determined to be one paid station to a square of ten miles, the number would be 1,222 stations, which at £5 per station would amount to £6,110 per annum. If the base were augmented to one paid station to every square of five miles of cultivated land, and one-fourth the number sufficed for uncultivated districts, the number would be 3,422 stations, and the cost £17,110 per annum. It is considered that by accepting the information of volunteers of a superior class, such as medical men, meteorologists, and other lovers of science, the number of observers might be readily increased, so as to meet local specialities of height, &c., if in return for the information so obtained the periodical publication of the registrar of rainfall was supplied to each correspondent.

The cost of rain gauges and fixing them may be estimated at 30s. each, taking as a basis the estimates of Mr. Casella and Messrs. Negretti and Co. The cost should be liquidated by annual instalments in the 20 years.

To maintain these gauges in working order (increased in expense by occasional changes of station and consequent damage), we must estimate the annual outlay at 25 per cent. of the first cost. To fix the guages after the presiding authorities have determined the stations, would require the aid, first of the survey department of the Ordnance to ascertain the height of each station and connect the whole with the Ordnance datum; and next, of superior officials, initiated in meteorology, to see that the guages are placed in a position free from the influence of trees and buildings, and in every respect in proper working order. The guages, when fixed, would require periodical inspection by an authorised officer, about once every year, and this would necessitate the maintenance of a staff of travelling inspectors.

The class of men required for inspectors of rain-guages would be practically the same as excisemen. It may be assumed that officers competent to perform the duties of excise supervisors would be equally capable of fixing and inspecting the guages, and of instructing observers on the mode of recording, &c., when once they where themselves initiated in their duties; and it might possibly be found desirable that the present staff of excise officers should be increased, so as to undertake the work.

These several items of annual expenditure amount to £27,270, if five-mile stations be adopted; and to £12,920 if ten-mile stations be adopted. Thus:—

For Five-Mile Stations.	£
Registrar's salary and expense of central office	1,500
Printing..	1,000
Annual payment to observers...	17,110
Annual instalment to repay first cost and fixing of rain-guages (7 per cent on £5,200)	375
Annual cost of maintaining the rain-guages in working order	1,285
Annual payments to inspectors of rain-guages...	5,000
	£26,270

For Ten Mile Stations.	£
Central office and printing	2,200
Observers	6,110
Annual charge for payment of first cost and of rain-guages (7 per cent. on £2,100)	150
Cost of maintaining them	460
Inspectors	4,000
	£12,920

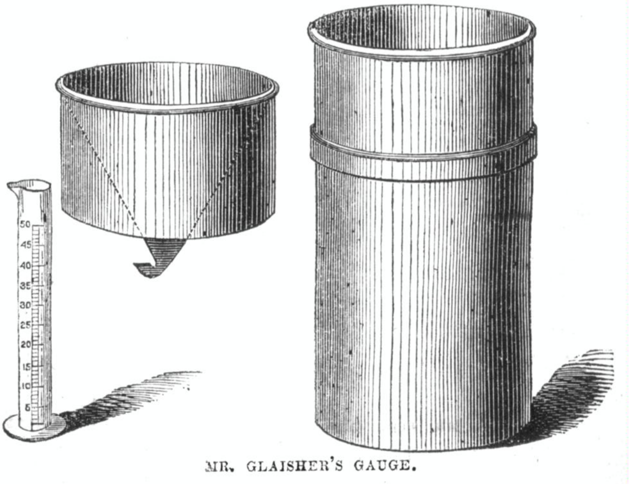
If the larger sum of the two were taken as the cost of obtaining an accurate and available return of the rainfall over the whole face of the country, it would result in a charge upon—

	£
England and Wales..................	15,000
Scotland	4,820
Ireland	6,200
British Isles	250
	£26,270

To represent this in a way that the country at large may be able to appreciate the extent to which they would individually subscribe, it should be stated that, to raise £26,270 on the rateable property of the United Kingdom, the charge would be one-tenth of a penny in the £1; or supposing the cost raised by county-rate, a person rated at £50 a-year, and paying 2½d. per annum for 20 years, would secure, for 4s. 2d., a perfect record of the supply of that element which contributes more than any other to the comforts and discomforts of man.

We must now refer to that important point, rain-guages, if it be only to admit that much difference of opinion still exists as to the size of the guage, and the height above ground at which it should be fixed, to gain the most accurate results.

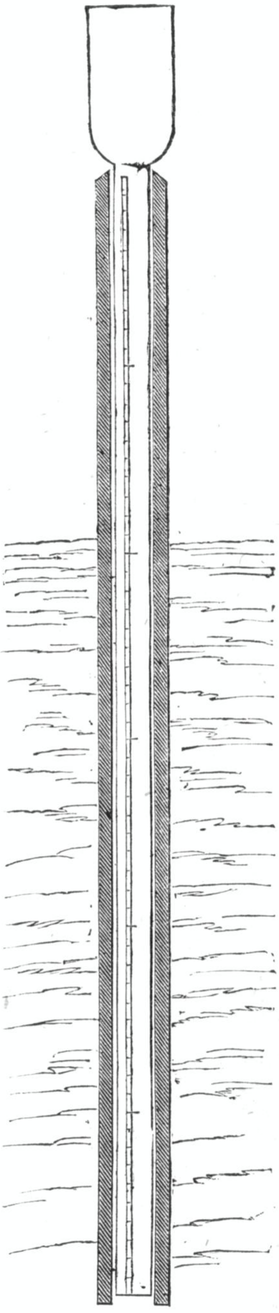
Mr. Glaisher, who is responsible in a great degree for the returns of the Registrar General, adopts the circular guage, with a receiving surface about eight inches dia-



MR. GLAISHER'S GAUGE.

meter, so fixed as to be five inches above ground.—(See "Meteorology," by James Glaisher, 1857.)

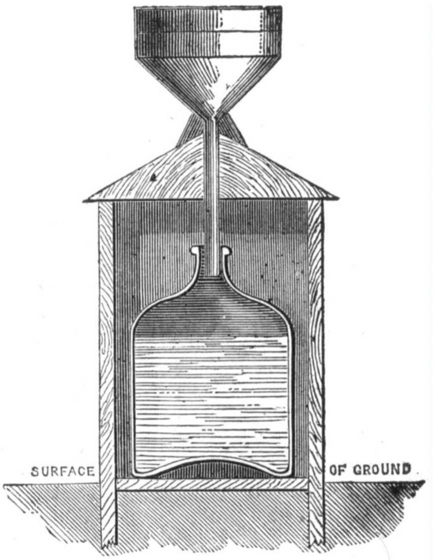
Mr. J. Bennett Lawes, of Rothampstead, who for a long time has taken a great interest in the subject, and has compared the daily results given by a guage of a size equal to $\frac{1}{1000}$th part of an acre with those of a small guage five inches in diameter, has given it as his opinion that the larger the guage the more accurate the return. —(See *Gardeners' Chronicle*, page 180, 1853.)



MR. STRATON'S GAUGE.

This, however, is directly opposed to the opinion of Mr. Straton, of Aberdeen, who, after careful investigation, has given it as his opinion that circular glass gauges 1, 2, or 3 inches in diameter, placed 15 inches above the surface, are the best guages that can be used, (See *Edinburgh New Philosophical Journal*, July, 1853,) and Mr. Welsh, of the Kew Observatory, states, in a note addressed to me, that he thinks "that there is much reason in what Mr. Straton says."

Mr. Homersham, in his report on the supply of water to Manchester, Salford, and Stockport (1848), has given the results of a series of experiments and records, which tend to shew that Mr. Glaisher's rain-gauges (to which he gives preference for some purposes) would not have answered in all cases



MR. HOMERSHAM'S GUAGE.

These conflicting opinions upon the very instrument by which we should measure the rainfall, lead us to the conclusion that the first step to be adopted by the authorities by whom the general registration would be conducted, would be to determine the size and shape of the guage, the height at which it should be placed under different circumstances, and the material of which it should be made. These points can only be determined by public authorities who have competent means of investigating them in a manner which no private individual can accomplish, and it would be no small gain to science if public necessity determined where errors have existed, and in what way they may be avoided in future.

In conclusion, I must remark that I have approached the object of this evening's discussion with considerable diffidence. I have felt that the subject of rainfall was only one branch of a very comprehensive science, and that it was hardly possible to do justice to it without embracing several kindred elements; and the time I have been able to devote to the subject, reduced as it has been to the closest limits, has been insufficient to allow me to do it justice even in its reduced shape. But I have been influenced by the conviction, forced on me by my daily practice as an agricultural engineer, that we are working in the dark, and I have wished, for my own sake, and for the sake of those who are following the same pursuits, to rescue the present generation from the opprobrium which must attach to it when its performances are tested by the experience and better data possessed by the next.

APPENDIX.—HINXWORTH DRAINAGE.—MONTHLY RECORDS FROM 1ST OCTOBER, 1856, TO 31ST MAY, 1857.

RECORD FOR OCTOBER, 1856.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	RAINFALL.		BAROMETER.	OCCASIONAL DRAINAGE.—FIELDS Nos. 18, 19, 20. 46 Acres.—Soil, lower Chalk mixed with Clay, Gravel, and Sand. Green Sand is found mixed with Gault Clay. Also Coprolites. Very wet before Draining. Nos. 19 and 20 only, containing 25 acres, drained at this time.				PART OCCASIONAL AND PART WIDE PARALLEL DRAINAGE. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed.		PARALLEL DRAINAGE. Fields 13 and part 14. 24 Acres.—Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856.		CLOSE PARALLEL DRAINAGE. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay, with Lime infiltrated. Considered very stiff and impenetrable. Drains, 25 feet apart, and 4 feet deep.					TEMPERATURE. At half-past Seven, a.m.					
				Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Holes 6 feet deep.		Quantity of Water from Outlet No. 7, which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 8 inches. Commenced running October 1.		Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, five inches. Commenced running October 12.		Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year.		Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Holes dug 5 feet deep.			Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running Nov. 27.		Undrained Land.			Drained Land.		
												Drained Land.										
Day of the Month.	Per Diem. Inches dec.	Per Acre. (Per Diem.) In Gallons.	Height at the time of recording the Discharge from the Outlets, 8 o'clock a.m. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	Higher Side.—Distance from Drain to Drain 59 yds. Depth of Drains 4 ft. 11 in.	Lower Side.—Distance from Drain to Drain 57 yds. Depth of Drains 4 ft. 4 in.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Higher Side. 25 ft. apart and 4 ft. deep. No. 31.	Lower Side. 25 ft. apart and 4 feet deep. No. 31.	Undrained Land. No. 33.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Of Air 9 inches above surface. No. 33.	Of Soil 18 inches below ground. No. 33.	Of Soil 42 inches below ground. No. 33.	Of Air 9 inches above surface. No. 31.	Of Soil 18 inches below ground. No. 31.	Of Soil 42 inches below ground. No. 31.
1	...	...	No record of the changes of the barometer made before 21st October, 1856.	5 11	5 4	1¼	75	Nil	Nil	1¼	75	Nil	Nil	No observations made this month.	Nil	Nil	No observations made this Month on the Temperature of the Soil.					
2	...	...		5 10	5 3	1¾	105	...	..	1¼	75	Nil	Nil		...	...						
3	...	...		5 9	5 2	1⅜	80	...	...	1¼	75	4 9½	4 9		...	...						
4	·105	2,375		5 8	5 0	1½	90	...	...	1¼	75	4 9½	4 9		...	...						
5	·200	4,525		5 6	4 10	2	120	...	...	1¾	75	4 9	4 8½		...	...						
6	·060	1,355		5 3½	4 8	1⅜	80	...	...	1⅜	80	4 8½	4 8		...	...						
7	·080	1,810		5 2	4 5	2	120	...	...	1¾	105	4 9	4 8½		...	...						
8	·185	4,185		5 0	4 3½	2⅝	160	...	...	19⅓	1,160	4 10	4 9¾		...	...						
9	·040	905		4 10	4 2	4	235	...	...	6¾	405	4 10½	4 10		...	...						
10	·060	1,355		4 9	4 1	6¼	360	...	...	6¾	405	4 11	4 10½		...	...						
11	·195	4,410		4 8	3 11	9	530	...	...	6½	390	4 11½	4 11		...	...						
12	·415	9,390		4 6	3 7	27½	1,585	1-4th	20	30	1,700	4 10½	4 10		...	...						
13	·005	115		4 5	3 8	24	1,410	1-4	20	8⅓	470	4 11	4 11		...	...						
14	...	...		4 4	3 9	19½	1,115	1-8	10	3¼	210	Nil	Nil		...	...						
15	·115	2,600		4 4½	3 9½	15	880	1-8	10	4	235	...	...		...	...						
16	·070	1,585		4 5	3 10	10½	605	1-8	10	6	350	...	...		...	...						
17	·100	2,260		4 5½	4 0	10	580	1·8	10	6	350	...	...		...	...						
18	·005	115		4 6	4 2	9	530	1-8	10	7	400	...	...		...	...						
19	...	...		4 6½	4 2	8½	495	1-8	10	6	350	...	...		...	...						
20	...	...		4 7	4 2	8	470	1-8	10	4	235	...	...		...	...						
21	...	...	30·12	4 7	4 2	8	470	1-9	9	3½	210	...	...		...	...						
22	...	...	30·28	4 7½	4 2½	7	400	1 9	9	3¼	195	...	..		...	...						
23	...	...	30·26	4 8	4 3	6½	375	1-10	8	3	180	...	...		...	...						
24	...	...	30·38	4 8½	4 3	6	350	1-12	7	3	180	...	...		...	...						
25	...	...	30·40	4 9	4 3	6	350	1-16	5	2¾	165	...	...		...	...						
26	...	...	30·39	4 9	4 3	5	285	1-16	5	2½	150	...	...		...	...						
27	...	...	30.36	4 9½	4 3	4¼	250	1-16	5	2⅜	140	...	...		...	...						
28	·002	45	30·28	4 10	4 3	4	235	1-16	5	2⅛	130	...	...		...	...						
29	·003	70	30·20	4 10	4 3	3¾	220	1-16	5	2	120	...	...		...	...						
30	...	...	30·10	4 10	4 3	3	175	1-16	5	2	120	...	...		...	...						
31	·005	115	30·05	4 10	4 3	3	175	1-16	5	1¾	105	...	...		...	...						
Total	1·645	37,215		Total quantity of Water per acre discharged			12,910		178		9,815											
				Remainder unaccounted for			24,305		37,037		28,800											
				Total Rainfall			37,215		37,215		37,215											

HINXWORTH DRAINAGE.—Record of the Month of November, 1856.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	Rainfall.		Barometer.	Occasional Drainage.—Fields Nos. 18, 19, 20. 46 Acres.—Soil, lower Chalk mixed with Clay, Gravel, and Sand. Green Sand is found mixed with Gault Clay. Also Coprolites. Very wet before draining. Nos. 19 and 20 only drained up to Nov. 10, when the draining of Nov. 18 was commenced. It was finished Nov. 29.				Part Occasional and part Wide Parallel Drainage. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed.		Parallel Drainage. Fields 13 and part 14. 24 Acres.—Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856.		Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay, with Lime infiltrated. Considered very stiff and impenetrable. Drains, 25 feet apart and 4 feet deep.					TEMPERATURE. At half-past Seven, a.m.					
				Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Holes 6 feet deep.		Quantity of Water from Outlet No. 7, which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 8 in. Commenced running October 1.		Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, five inches. Commenced running October 12.		Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year.		Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Holes 5 feet deep.			Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running Nov. 27.		Undrained Land.			Drained Land.		
												Drained Land.										
Day of the Month.	Per diem. Inches dec.	Per Acre. (Per Diem.) In Gallons.	Height at the time of recording the Discharge from the Outlets, 8 o'clock, a.m. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	Higher Side.—Distance from Drain to Drain 59 yds. Depth of Drains 4 ft. 11 in.	Lower Side.—Distance from Drain to Drain 57 yds. Depth of Drains 4 ft. 4 in.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Higher Side. 25 ft. apart and 4 ft. deep. No. 31.	Lower Side. 25 ft. apart and 4 ft. deep. No. 31.	Undrained Land. No. 33.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Of Air 9 inches above surface. No. 33.	Of Soil 18 inches below ground. No. 33.	Of Soil 42 inches below ground. No. 33.	Of Air 9 inches above surface. No. 31.	Of Soil 18 inches below ground. No. 31.	Of Soil 42 inches below ground. No. 31.
1	·312	7,058	30·28	4 10	4 3	9½	555	1-8th	10	2¾	165	Nil	Nil	No observations made prior to November 27.	Nil	Nil	No observations made this Month on the Temperature of the Soil.					
2	·003	68	30·29	4 10	4 3	5	285	1-9	9	1¾	105	...	...		...	...						
3	...	...	30·19	4 10	4 3	3	175	1-10	8	1½	90	...	...		...	...						
4	...	...	30·18	4 10	4 3	3	175	1-10	8	1¼	75	...	...		...	...						
5	...	...	30·30	4 10	4 3	3	175	1-10	8	1	60	...	...		...	...						
6	...	...	30·40	4 10	4 3	3	175	1-10	8	1	60	...	...		...	...						
7	·005	113	30·50	4 10	4 3	3	175	1-10	8	1	60	...	...		...	...						
8	...	...	30·37	4 10	4 3	3	175	1-10	8	1½	90	...	...		...	...						
9	·355	8,030	30·06	4 10	4 3	12	700	2-3	50	6	360	...	...		...	...						
10	·005	113	29·50	4 10	4 3	5⅝	Field No. 18 being drained and added to this outlet, and the daily measurements were only approximately taken.	3-8	30	5½	330	...	...		...	...						
11	...	...	29·30	4 10	4 3	5		3-8	30	5½	330	...	...		...	...						
12	·215	4,864	29·60	4 9	4 3	6⅞		1-2	40	5½	330	...	...		...	...						
13	·002	45	29·70	4 9	4 3	7		1-2	40	5	300	...	...		...	...						
14	·003	68	29·79	4 9	4 3	7½		3-8	30	4¾	285	...	...		...	...						
15	...	...	29·80	4 9	4 3	7½		3-8	30	4¾	285	...	...		...	...						
16	...	...	30·10	4 9	4 3	8		1-4	20	3½	210	...	...		...	...						
17	...	...	30·10	4 9	4 3	9		1-4	20	2½	150	...	...		...	...						
18	·040	905	30·00	4 9	4 3	9		1-4	20	2¼	135	...	...		...	...						
19	·072	1,628	30·04	4 9	4 3	12½		1-3	25	2¼	135	...	...		...	...						
20	·053	1,199	29·09	4 9	4 3	15		1-2	40	2¼	135	...	...		...	...						
21	·005	113	30·15	4 9	4 3	15¾		1-2	40	2¼	135	...	...		...	...						
22	...	...	30·17	4 9	4 3	16		1-3	25	2¼	135	...	...		...	...						
23	...	...	29·70	4 9	4 3	16		1-3	30	2¼	135	...	...		...	...						
24	...	...	29·60	4 9	4 3	17		1-3	25	2¼	135	...	...		...	...						
25	...	...	29·50	4 9	4 3	17		1-3	30	2¼	135	...	...		...	...						
26	·015	339	29·60	4 9	4 2½	17¾		1-3	25	3¼	195	...	...		...	...						
27	·540	12,216	29·58	4 8	4 2	33		11¼	900	12¼	735	4 11	4 11	3 0	2¾	135						
28	·005	113	29·68	4 7	4 0	34½		3	240	5	300	4 11½	4 11½	2 10	1¼	65						
29	...	...	29·68	4 7½	4 1	32		2	160	4	240	...	...	2 10	1¼	65						
30	...	...	29·69	4 7½	4 1	30		2	160	3	180	...	...	2 9⅛	1¼	65						
Total	1·630	36,872		Total quantity of Water per acre discharged			27,000		2,077		6,015					330						
	1·645	37,215		Remainder unaccounted for			9,872		34,795		30,857					36,542						
	3·275	74,087		Total Rainfall			36,872		36,872		36,872					36,872						

HINXWORTH DRAINAGE.—Record of the Month of December, 1856.

Occasional Drainage.—Fields Nos. 18, 19, 20. (Columns 4–7.) 46 Acres.—Soil, lower Chalk mixed with Clay, Gravel, and Sand. Green Sand is found mixed with Gault Clay. Also Coprolites. Very wet before Draining.

Part Occasional and part Wide Parallel Drainage. (Columns 8–9.) 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed.

Parallel Drainage. (Columns 10–11.) Fields 13 and part 14. 24 Acres.—Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856.

Close Parallel Drainage. (Columns 12–16.) Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay, with Lime infiltrated. Considered very stiff and impenetrable. Drains, 25 feet apart, and 4 feet deep.

Temperature. (Columns 17–22.) At half-past Seven, a.m.

Columns 4, 5: Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes 6 feet deep.

Columns 6, 7: Quantity of Water from Outlet No. 7, which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 8 inches. Commenced running October 1.

Columns 8, 9: Quantity of Water from Outlet No. 9, which discharges the Drain Water from No 22. Size of Pipe, five inches. Commenced running October 12.

Columns 10, 11: Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year.

Columns 12, 13, 14: Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. Test holes dug 5 feet deep.

Columns 15, 16: Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running Nov. 27.

Day of the Month.	1. Rainfall. Per diem. Inches dec.	2. Rainfall. Per Acre. (Per Diem.) In Gallons.	3. Barometer. Height at the time of recording the Discharge from the outlets, 8 o'clock, a.m. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	4. Higher Side.—Distance from Drain to Drain 59 yds. Depth of Drains 4 ft. 11 in.	5. Lower Side.—Distance from Drain to Drain 57 yds. Depth of Drains 4 ft. 4 in.	6. Per Minute. In Gallons.	7. Per Acre. In Gallons (per diem).	8. Per Minute. In Gallons.	9. Per Acre. In Gallons (per diem).	10. Per Minute. In Gallons.	11. Per Acre. In Gallons (per diem).	12. Drained Land. Higher Side. 25 ft. apart and 4 ft. deep. No. 31.	13. Drained Land. Lower Side. 25 ft. apart and 4 ft. deep. No. 33.	14. Undrained Land. No. 33.	15. Per Minute. In Gallons.	16. Per Acre. In Gallons (per diem).	17. Undrained Land. Of Air 9 inches above surface. No. 33.	18. Undrained Land. Of Soil 18 inches above ground. No. 33.	19. Undrained Land. Of Soil 42 inches below ground. No. 33.	20. Drained Land. Of Air 9 inches above surface. No. 31.	21. Drained Land. Of Soil 18 inches below ground. No. 31.	22. Drained Land. Of Soil 42 inches below ground. No. 31.
1	...	...	29·80	4 8	4 1	28½	895	1½	120	4⅞	295	Nil	Nil	2 9	1¼	65	No observations made this Month on the Temperature of the Soil.					
2	...	...	29·80	4 8	4 1	25	780	1¾	140	3½	210	...	...	2 7	1⅛	55						
3	...	...	29·69	4 8	4 1½	22½	695	1⅞	150	2¼	135	...	...	2 6	⅝	30						
4	...	...	29·90	4 8	4 1½	20	620	1⅞	150	2	120	...	...	2 6	⅝	30						
5	·073	1,651	29·59	4 8	4 1½	25½	795	1⅞	150	3⅜	200	...	...	2 5	¾	40						
6	·027	610	29·40	4 8	4 1½	24½	735	1⅞	150	3⅜	200	...	...	2 5½	¾	40						
7	·050	1,131	29·49	4 8	4 1½	25½	795	2	160	4	235	...	...	2 5	⅞	45						
8	...	...	29·49	4 8	4 1½	24½	735	2¼	180	4¾	225	...	...	2 4½	⅞	45						
9	·080	1,816	29·40	4 8	4 1½	27	830	3	240	5	300	...	...	2 4	⅞	45						
10	·060	1,357	29·30	4 8	4 1½	26¼	820	3	240	5¼	315	4 11½	4 11	2 4	1	50						
11	·075	1,696	29·40	4 8	4 1½	24	755	6	480	15	900	4 11	4 11	2 4	2	100						
12	·085	1,923	29·27	4 8	4 1½	22½	695	8	640	22½	1,250	4 10½	4 10	2 3½	3⅛	160						
13	·452	10,225	28·89	3 8	2 11	77½	2,420	19	1,520	47½	2.850	4 9	4 9	6	19½	975						
14	·023	520	29·40	3 10	3 0	55	1,715	10	800	25	1,500	4 9	4 8	7	15	730						
15	...	...	30·20	3 10	3 2	47½	1,485	6	480	15¾	945	4 9	4 8	7	13½	675						
16	...	...	30·49	4 0	3 7	47½	1,485	6	480	10½	630	4 9	4 8	10	7½	375						
17	...	...	30·37	4 1½	4 0	46¾	1,455	6	480	9	540	4 9	4 8	10½	8¼	415						
18	...	...	29·80	4 0½	4 0½	40	1,245	5⅝	450	6¾	405	4 9	4 8	11	3¾	185						
19	·100	2,262	30·30	4 2	4 2	34¼	1,095	6⅞	550	8	480	4 9	4 8	1 0	4½	225						
20	·005	113	30·38	4 2	4 2	37	1,145	6½	520	7½	450	4 9	4 8	1 1	3⅛	160						
21	...	...	30·39	4 2	4 2	35	1,095	5¾	460	7½	450	4 9	4 8	1 1	3	150						
22	...	...	30·00	4 2½	4 2½	33	1,030	5¼	420	7½	450	4 9	4 9	1 2	2½	125						
23	...	...	29·90	4 4	4 4	33	1,030	4⅞	395	7½	450	4 9	4 9	1 4	2¼	110						
24	·045	1,018	29·40	4 3	4 3	35	1,095	4¾	380	7	420	4 8	4 9	1 4	2	100						
25	...	...	28·80	4 5	4 5	30	935	4½	360	6	360	4 8	4 10	1 4	2	100						
26	...	...	28·70	4 6	4 6	26¼	820	4¼	340	5¼	315	4 8	4 10	1 4	1⅞	95						
27	...	...	29·19	4 6	4 6	21	660	3½	280	4	235	4 8	4 10	1 4	1¼	65						
28	...	...	29·46	4 6½	4 6½	19	595	3	240	3	180	4 9	4 10	1 4	1	50						
29	...	...	29·80	4 7	4 7	15¼	935	2¼	180	2⅝	160	4 9	4 10	1 4	¾	40						
30	·150	3,393	30·10	4 6	4 6	19	595	5	400	6½	390	4 7	4 9	1 3	6	300						
31	·010	226	30·14	4 6½	4 2	18¾	590	4½	360	5⅝	340	4 6½	4 9	1 3	4½	225						
Total	1·235	27,935		Total quantity of Water per Acre discharged			30,565		11,895		15,935					5,825						
				Rainfall			27,935	Difference unaccounted for..	26,040		12,000					22,110						
				Excess discharged from the Soil			2,630	Rainfall	27,935		27,935					27,935						

HINXWORTH DRAINAGE.—RECORD OF THE MONTH OF JANUARY, 1857.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	RAINFALL.		BAROMETER.	OCCASIONAL DRAINAGE.—FIELDS Nos. 18, 19, 20. 46 Acres.—Soil, lower Chalk mixed with Clay, Gravel, and Sand. Green Sand is found mixed with Gault Clay. Also Coprolites. Very wet before Draining.				PART OCCASIONAL AND PART WIDE PARALLEL DRAINAGE. Field No. 22. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed.		PARALLEL DRAINAGE. Fields 13 and part 14. 24 Acres.—Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856.		CLOSE PARALLEL DRAINAGE. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay, with Lime infiltrated. Considered very stiff and impenetrable. Drains, 25 feet apart, and 4 feet deep.					TEMPERATURE. At half-past Seven, a.m.					
				Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes 6 feet deep.		Quantity of Water from Outlet No. 7, which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 8 inches. Commenced running October 1.		Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, five inches. Commenced running October 12.		Quantity of Water from Outlet No 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year.		Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Test Holes 5 feet deep.			Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running Nov. 27.		Undrained Land.			Drained Land.		
												Drained Land.										
Day of the Month.	Per Diem. Inches dec.	Per Acre. (Per Diem.) In Gallons.	Height at the time of recording the Discharge from the Outlets, 8 o'clock a.m. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	Higher Side.—Distance from Drain to Drain 59 yds. Depth of Drains 4 ft. 11 in.	Lower Side.—Distance from Drain to Drain 57 yds. Depth of Drains 4 ft 4 in.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem.)	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per Acre. In Gallons (per diem.)	Higher side. 25 ft. apart and 4 feet deep. No. 31.	Lower Side. 25 ft. apart and 4 feet deep. No. 31.	Undrained Land. No. 33.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Of Air 9 inches above surface. No. 33.	Of Soil 18 inches below ground. No. 33.	Of Soil 42 inches below ground. No. 33.	Of Air 9 inches above surface. No. 31.	Of Soil 18 inches below ground. No. 31.	Of Soil 42 inches below ground. No. 31.
1	005	113	30 30	4 6	4 2	16	500	2½	200	4¼	250	4 6	4 6	1 2	2	100	No observations made prior to the 6th of this month.					
2	·020	452	29·48	4 6	4 2	21	660	3¾	300	5	300	4 6	4 6	1 2	3⅜	170						
3	·042	950	29·20	4 6	4 2	24	750	5	400	9¼	550	4 5	4 5	1 2	8	400						
4	·151	3,416	29 07	4 6	4 1	29	900	14½	1,150	33	1,900	4 4	4 4	1 2	18	900						
5	·162	3,665	29·64	4 6	4 1	31	980	15¾	1,260	40½	2,430	4 3	4 3	1 1½	21	1,050						
6	...	...	30·09	4 5½	4 0½	30	930	11¼	900	19½	1,170	4 3	4 3½	1 3	12	600	31	...	No observations recorded.	31	...	No observations recorded.
7	...	...	30·20	4 5	4 0	31½	995	7¼	580	18½	1,130	4 3	4 3½	1 2½	4½	225	32	34		33	34	
8	...	...	30·24	4 5	4 1	28½	895	5¼	420	9	540	4 3	4 3	1 3	3	150	34	34		36	35	
9	·035	792	30 13	4 4½	4 0	29	910	5	400	8	480	4 3	4 3½	1 3	2⅝	125	37	35		38	36	
10	·542	12,261	29·46	3 5	2 8	62	1,945	45	3,600	101½	6,060	4 0	4 0	0 5	103	5,150	44	36		44	37	
11	·300	6,787	28·80	3 0	2 2	57½	1,800	40	3,200	75	4,500	4 0	4 0	0 5	88	4,000	37	37		43	38	
12	·162	3,665	29·19	2 1	1 11	53¾	1,680	30¾	2,460	46½	2,790	3 11	3 11	0 4	40	1,990	37	37		32	38	
13	...	...	29·39	2 7	2 5	55	1,720	22½	1,800	35	2,085	4 0	4 0	0 5	25	1,250	32	37		31	37	
14	...	...	29·80	3 2	2 11	55	1,720	12¾	1,020	18	1,080	4 0	4 0	0 6	12	600	28	36		29	37	
15	...	...	29·90	3 6	3 3	50	1,560	9	720	11¼	660	4 0	4 0	0 9	7½	375	32	35		33	35	
16	·135	3,054	29 90	3 10	3 8	52½	1,640	9¾	780	14¼	840	4 1	4 1	1 0	8¼	410	27	34		31	35	
17	...	...	30·20	4 1½	4 0	51½	1,605	9	720	13½	840	4 1½	4 2	1 0	7½	375	29	31		33	34	
18	·005	113	30·19	4 2	4 0	48	1,500	9	720	14¼	850	4 1	4 2	1 0	7½	375	43	30		44	35	
19	·005	113	30·17	4 3½	4 1	45	1,395	9	720	15¾	945	4 1	4 2	1 0	7½	375	41	36		42	36	
20	...	...	29·69	4 3	3 11½	43¾	1,350	9¾	780	16¾	1,005	4 0	4 0	1 0½	8¼	410	38	32		39	37	
21	·065	1,470	29·40	4 2	3 11	50	1,560	16½	1,320	24	1,440	3 10½	3 10	1 0	13½	680	32	31		32	36	
22	·120	2,714	29·69	4 1	3 10	52½	1,640	17¼	1,380	24¾	1,485	3 10	3 10	0 10	19¾	985	29	32		30	37	
23	·062	1,402	29·28	4 0½	3 9	53¾	1,680	18	1,440	24	1,440	3 9	3 9	0 9	19¾	985	32	31		34	35	
24	·035	792	29·04	4 1	3 10	52½	1,640	16½	1,320	22¼	1,310	3 9½	3 9	0 10	18	900	35	33		36	37	
25	·145	3,280	29·27	4 0	3 8	61	1,900	37½	3,000	56¼	3,400	3 8	3 9	0 10	54	2,700	34	32		35	36	
26	·130	2,940	29·59	3 7	3 7	62½	1,960	45	3,600	57½	3,450	3 5	3 9	0 10	55	2,750	31	32		32	34	
27	·112	2,534	29·70	3 7	3 3	57½	1,800	21	1,680	41½	2,460	3 2½	3 2½	1 0	35	1,750	28	33		29	35	
28	...	...	29·79	3 9	3 5	56¼	1,770	11	880	20¼	1,200	3 3	3 3	1 0	15	750	17	33		18	35	
29	...	...	29·70	3 10½	3 6½	51¼	1,595	10½	840	16⅔	995	3 3½	3 3½	1 0	11¼	560	16	32		17	34	
30	...	...	29·73	4 0	3 9	45	1,395	9	720	13¼	795	3 4	3 4	1 0	6¾	340	21	31		22	33	
31	·100	2,262	29·58	4 0½	3 8	47½	1,480	9¾	780	15	900	3 3	3 3	0 11	7½	375	30	33		31	34	
Total	2.333	52,775		Total quantity of Water per acre discharged			43,855		39,090		49,250					31,805						
				Remainder unaccounted for			8,920		13,685		3,525					20,970						
				Total Rainfall...............			52,775		52,775		52,775					52,775						

HINXWORTH DRAINAGE.—Record of the Month of February, 1857.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	RAINFALL.		BAROMETER.	OCCASIONAL DRAINAGE.—FIELDS Nos. 18, 19, 20. 46 Acres.—Soil, lower Chalk mixed with Clay, Gravel, and Sand. Green Sand is found mixed with Gault Clay. Also Coprolites. Very wet before Draining.				PART OCCASIONAL AND PART WIDE PARALLEL DRAINAGE. Field No. 22. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed.		PARALLEL DRAINAGE. Fields 13 and part 14. 24 Acres.—Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856.		CLOSE PARALLEL DRAINAGE. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay, with Lime infiltrated. Considered very stiff and impenetrable. Drains, 25 feet apart, and 4 feet deep.					TEMPERATURE. At half-past Seven, a.m.					
				Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes 6 feet deep.		Quantity of Water from Outlet No. 7, which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 8 inches. Commenced running October 1.		Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, five inches. Commenced running October 12.		Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year.		Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Test Holes 5 feet deep.			Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches Commenced running Nov. 27.		Undrained Land.			Drained Land.		
												Drained Land.										
Day of the Month.	Per Diem. Inches dec.	Per Acre. (Per Diem.) In Gallons.	Height at the time of recording the Discharge from the Outlets, 8 o'clock a.m. Note.—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	Higher Side.—Distance from Drain to Drain 59 yds. Depth of Drains 4 ft. 11 in.	Lower Side.—Distance from Drain to Drain 57 yds. Depth of Drains 4 ft. 4 in.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem.)	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Higher Side. 25 ft. apart and 4 feet deep. No. 31.	Lower Side. 25 ft. apart and 4 feet deep. No. 31.	Undrained Land. No. 33.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Of Air 9 inches above surface. No. 33.	Of Soil 18 inches below ground. No. 33.	Of Soil 42 inches below ground. No. 33.	Of Air 9 inches above surface. No. 31.	Of Soil 18 inches below ground. No. 31.	Of Soil 42 inches below ground. No. 31.
1	...	...	29·79	4 1	3 8	40	1,245	7	560	12	720	...	...	1 0	7	350	27	32	No observations recorded prior to the 21st of this month.	28	33	39
2	...	...	29·59	4 2	3 8½	33¾	1,055	6¾	540	8¼	495	3 1½	3 3½	1 0	6	300	25	32		26	33	39
3	...	...	29·60	4 3½	3 9	32½	1,015	6	480	6¾	405	3 2	3 4	1 1	5¼	260	21	32		22	33	38
4	...	...	30·07	4 5	3 10	32½	1,015	4½	360	5¼	315	3 3	3 5	1 2	3¾	185	24	31		25	32	38
5	...	...	30·08	4 6	3 11½	35	1,095	6	480	6¾	405	3 4	3 6	1 2	5¼	265	26	32		27	33	38
6	·100	2,262	29·77	4 5	3 11	38¾	1,210	12¾	1,020	9½	570	3 2	3 4	1 2	9	450	27	32		28	33	38
7	·025	565½	29·67	4 4	3 10	50	1,560	16½	1,320	31½	1,890	2 10	3 0	1 0	25	1,250	40	31		41	33	38
8	...	...	29·59	4 4	4 0	45	1,395	12	960	18	1,080	2 10	2 11	1 0	17	850	38	32		39	34	38
9	...	...	29·58	4 4	4 1	41½	1,285	9	720	10½	630	2 10	2 11	1 0	12	600	44	32		45	33	38
10	·022	497½	29·57	4 5	4 2	40	1,245	9	720	9¾	585	2 10	2 11	1 1	9	450	35	33		36	34	37
11	·020	452½	29·69	4 6	4 3	37½	1,175	8½	680	10½	630	3 0	2 11	1 2	7½	375	35	34		36	35	37
12	·010	226¼	30·20	4 7	4 4	36½	1,150	6¾	540	9¾	585	3 1	3 0	1 2	7½	375	31	35		32	36	38
13	...	...	30·20	4 7½	4 4	37½	1,175	6¾	540	9¾	585	3 2	3 1	1 2	7½	375	32	35		33	36	38
14	...	...	30·20	4 8	4 4	35	1,090	6¾	540	9	540	3 3	3 2	1 2½	7½	375	40	34		40	35	38
15	...	...	30·16	4 8	4 4	32	1,000	6	480	8¾	525	3 3	3 2	1 3	6½	325	32	34		33	35	38
16	...	...	30·05	4 9	4 4	30	935	6	480	8¾	525	3 4	3 3	1 3	6	300	25	35		25	36	39
17	...	...	30·00	4 9½	4 4	27½	860	4½	360	7½	450	3 4½	3 4	1 3	5¼	260	42	35		41	35	40
18	...	...	29·90	4 10	4 4	27½	860	4½	360	6¼	375	3 5	3 5	1 3½	4½	225	40	35		40	36	40
19	...	...	30·09	4 10½	4 4	26¼	820	4½	360	6¼	375	3 5½	3 6	1 3½	3¾	185	42	35		41	37	40
20	·015	339¼	30·14	4 10½	4 4	25	780	4½	360	5	300	3 6	3 6½	1 3½	3¾	185	40	36		39	38	40
21	...	...	30·18	4 11	4 4	23¾	745	4	320	5	300	3 6½	3 7	1 4	3	150	42	37		40	39	41
22	...	...	30·19	4 11	4 4	22	690	4	320	4	240	3 7	3 8	1 5	3	150	42	37	39	42	39	41
23	...	...	30·19	4 11	4 4	21	660	4	320	3¾	225	3 7	3 8	1 5½	3	150	34	37	39	34	39	41
24	...	...	30·20	4 11	4 4	21	660	3¾	300	3	180	3 7½	3 8	1 6	3	150	40	37	39	40	39	41
25	...	...	30·10	4 11	4 4	21	660	3¾	300	3	180	3 8	3 8½	1 6	3	150	30	37	39	31	39	41
26	...	...	30·38	4 11	4 4	21	660	3¾	300	3	180	3 8	3 9½	1 6	3	150	23	37	39	23	39	41
27	...	...	30·37	4 11	4 4	21	660	3¾	300	3	180	3 8	3 10½	1 6	2¼	110	36	37	39	36	39	41
28	...	...	30·39	4 11	4 4	21	660	3¾	300	3	180	3 8½	3 11½	1 6	2¼	110	43	37	39	43	39	41
Total	·192	4,343		Total quantity of water per acre discharged			27,360		14,320		13,650					9,060						
				Rainfall			4,343		4,343		4,343					4,343						
				Excess discharged from soil			23,017		9,977		9,307					4,717						

HINXWORTH DRAINAGE.—RECORD OF THE MONTH OF MARCH, 1857.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	RAINFALL.		BARO-METER.	OCCASIONAL DRAINAGE.—FIELD No. 40. 16 Acres.—Soil. lower Chalk mixed with Clay Gravel and Sand. Very wet before Draining. (The fields are changed because Coprolites were raised in No. 19 this month, and interfered with the discharge).				PART OCCASIONAL AND PART WIDE PARALLEL DRAINAGE. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed.		PARALLEL DRAINAGE. Fields 13 and part 14. 24 Acres.—Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856.		CLOSE PARALLEL DRAINAGE. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay, with Lime infiltrated. Considered very stiff and impenetrable. Drains, 25 feet apart, and 4 feet deep.					TEMPERATURE. At half-past Seven, a.m,					
				Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes, 8 feet deep.		Quantity of Water from Outlet No. 8, which discharges the Drain Water from Field No. 40.		Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, five inches. Commenced running October 12.		Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year.		Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Holes 5 feet deep.			Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running Nov. 27.		Undrained Land.			Drained Land.		
												Drained Land.										
Day of the Month.	Per Diem. Inches dec.	Per Acre. (Per Diem.) In Gallons.	Height at the time of recording the Discharge from the Outlets, 8 o'clock, a.m. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	Higher Side.—Distance from Drain to Drain 75 yds. Depth of Drains 7 ft. 6 in.	Lower Side.—Distance from Drain to Drain 33 yds. Depth of Drains 6 ft.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Higher Side. 25 ft. apart and 4 feet deep. No. 31.	Lower Side. 25 ft. apart and 4 feet deep. No. 31	Undrained Land. No. 33.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Of Air 9 inches above surface. No. 33.	Of Soil 18 inches below ground. No. 33.	Of Soil 42 inches below ground. No. 33.	Of Air 9 inches above surface. No. 31.	Of Soil 18 inches below ground. No. 31.	Of Soil 42 inches below ground. No. 31.
1	...	...	30·49	4 2	5 6½	4½	405	3¾	300	3	180	3 9	3 11	1 6	2¼	110	35	37	39	36	40	41
2	...	...	30·48	4 2½	5 6½	4½	405	3¾	300	3	180	3 9	3 11	1 6	2¼	110	43	37	39	44	40	41
3	...	...	30·39	4 2½	5 6½	4½	405	3⅛	250	3	180	3 9	4 0	1 6	2¼	110	43	38	40	44	41	42
4	...	...	30·08	4 3	5 6½	4½	405	3	240	3	180	3 9½	4 0	1 6	2¼	110	44	38	40	43	41	42
5	...	...	30·28	4 3½	5 6½	4½	405	2⅝	210	3	180	3 9½	4 0	1 6	2¼	110	24	38	40	25	41	42
6	...	...	30·00	4 4	5 6½	5¼	472½	3¾	300	4½	270	3 9½	4 0	1 6	3	150	45	38	40	45	41	42
7	...	...	29·85	4 4½	5 6½	5¼	472½	3¾	300	4½	270	3 9½	4 0	1 6	3	150	34	38	40	34	41	42
8	...	...	29·49	4 5	5 6½	5	450	3¾	300	4½	270	3 10	4 0	1 6	3	150	47	38	40	46	41	42
9	·030	675	29·66	4 5	5 7	4½	405	2⅝	210	4½	270	3 10	4 0	1 6	3	150	38	37	40	39	40	42
10	·050	1,130	29·90	4 6	5 7	4½	405	3	240	5¼	315	3 10	4 0	1 6	3¾	190	27	36	39	28	39	41
11	·065	1,470	29·80	4 7	5 7	5¼	472½	3½	280	6	360	3 10	4 0	1 6	4½	225	31	36	39	32	38	41
12	...	...	29·89	4 8	5 7	5¼	472⅛	4½	360	6	360	3 10	4 0	1 6	4½	225	32	36	39	32	38	41
13	...	...	29·79	4 9	5 7	5¼	472½	4½	360	5¼	315	3 10	4 0	1 6	3¾	190	31	36	39	31	38	41
14	·060	1,360	29·00	4 9½	5 7	5¼	472½	5¼	420	5¼	315	3 10	4 0	1 6	3¾	190	42	36	40	42	39	41
15	·033	746	29·25	4 9½	5 7	5	450	4½	360	4	240	3 10	4 0	1 6	3	150	43	37	40	44	40	41
16	...	...	29·79	4 10	5 7	3	270	3¾	300	3	180	3 10	4 0	1 6	2¼	112	37	38	40	37	40	41
17	...	...	29·80	4 11	5 7	2¼	200	3¾	300	2¼	135	3 10	4 0	1 6	1½	75	42	38	40	42	40	41
18	...	...	29·69	5 0	5 7	1½	135	4¼	180	3	180	3 10	4 0	1 6½	1½	75	46	38	40	46	40	41
19	·040	905	29·79	5 1	5 7	¾	67½	3¾	300	1½	90	3 11½	4 0	1 7	¾	37	49	40	41	48	42	42
20	·100	2,262	29·80	5 1½	5 7	¾	67½	2¼	180	1½	90	3 11½	4 0	1 7½	¾	38	47	41	41	47	43	42
21	...	...	30·00	5 2	5 7	¾	67½	2¼	180	1½	90	4 0	4 9	1 7½	¾	38	36	41	41	37	43	42
22	...	...	29·80	5 2	5 7	¾	67½	2¼	180	1½	90	4 0	4 0	1 7½	¾	38	34	40	41	35	42	42
23	·122	2,760	29·60	5 2½	5 7	1½	135	2¼	180	1½	90	4 0	4 0	1 7	¾	38	33	39	41	34	41	42
24	·010	227	29·59	5 3	5 7	1½	135	2¼	180	2¼	135	4 0	4 0	1 7	1½	75	38	33	41	38	40	42
25	·015	339	29·40	5 3	5 7	1½	135	2¼	180	2¼	135	4 0	4 0	1 7	1½	75	43	38	41	43	40	42
26	·005	113	29·59	5 3	5 7	¾	67½	2¼	180	1½	90	4 0	4 0	1 7	¾	38	38	38	41	38	40	42
27	...	...	29·88	5 3	5 7	¾	67½	2¼	180	1½	90	4 0	4 0	1 7	¾	38	41	39	41	42	41	42
28	...	...	30·00	5 3½	5 7	¾	70	2½	200	1½	90	4 0	4 0	1 7	¾	38	42	40	41	43	42	42
29	·030	678	29·78	5 3	5 6	1	90	2½	200	2	120	4 0	4 0	1 6	1	50	41	40	41	41	42	42
30	·180	4,072	29·28	5 3	5 6	1½	135	3	240	3	180	4 0	4 0	1 5	2¼	112	42	40	42	42	42	43
31	·080	1,810	29·18	5 3	5 6	1½	135	3	240	3	180	3 11½	3 11½	1 4	2¼	113	42	41	42	43	43	43
Total	·820	18,547		Total quantity of water per acre discharged ……………………………			8,415		7,830		5,850					3,310						
				Remainder unaccounted for …………			10,132		10,717		12,697					15,237						
				Total Rainfall .. …………			18,547		18,547		18,547					18,547						

HINXWORTH DRAINAGE.—Report of the Month of April, 1857.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	29	21	22
	RAINFALL.		BAROMETER.	OCCASIONAL DRAINAGE.—FIELD No. 40. 16 Acres.—Soil, lower Chalk mixed with Clay' Gravel, and Sand, Very wet before Draining.				PART OCCASIONAL AND PART WIDE PARALLEL DRAINAGE. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed.		PARALLEL DRAINAGE. Fields 13 and part 14. 24 Acres.—Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856.		CLOSE PARALLEL DRAINAGE. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay, with Lime infiltrated. Considered very stiff and impenetrable. Drains, 25 feet apart, and 4 feet deep.					TEMPERATURE. At half past Seven, a.m.					
				Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes 8 feet deep.		Quantity of Water from Outlet No. 8, which discharges the Drain Water from Field No. 40.		Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, five inches. Commenced running October 12.		Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year.		Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Holes 5 feet deep.			Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running Nov. 27.		Undrained Land.			Drained Land.		
												Drained Land.										
Day of the Month.	Per Diem. Inches dec.	Per Acre. (Per Diem). In Gallons.	Height at the time of recording the Discharge from the Outlets, 8 o'clock, a.m. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	Higher Side.—Distance from Drain to Drain 75 yds. Depth of Drains 7 ft. 6 in.	Lower Side.—Distance from Drain to Drain 33 yds. Depth of Drains 6 ft.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Higher Side. 25 ft. apart and 4 ft. deep. No. 31.	Lower Side. 25 ft. apart and 4 feet deep. No. 31.	Undrained Land. No. 33.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Of Air 9 inches above surface. No. 33.	Of Soil 18 inches above ground. No. 33.	Of Soil 42 inches below ground. No. 33.	Of Air 9 inches above surface. No. 31.	Of Soil 18 inches below ground. No. 31.	Of Soil 42 inches below ground, No. 31.
1	·050	1,131	29·37	5 3	5 6	¾	67	2¼	180	1½	90	3 11½	3 11½	1 3	2¼	110	45	41	42	45	43	43
2	...	...	29·15	5 3	5 6	¾	67	2¼	180	1½	90	3 11½	3 11½	1 3	1½	75	46	42	42	49	44	43
3	·015	339	29·48	5 3½	5 6	¾	68	2¼	180	1½	90	3 11½	3 11½	1 3	1½	75	48	42	42	47	44	43
4	·060	1,357	29·67	5 4	5 6	¾	68	2¼	180	1½	90	4 0	4 0	1 3½	¾	37	47	43	42	48	45	43
5	·460	10,406	29·69	5 6	5 6	3	270	9	720	13½	810	4 0	3 11½	1 3	8¼	410	44	44	43	45	46	44
6	·035	792	29·58	5 8	5 5	3	270	9	720	13½	810	4 0	3 11	1 2	8¼	415	42	45	43	46	47	44
7	...	...	29·80	5 8	5 5	3	270	6	480	12	720	4 0	3 11	1 2	7½	375	45	46	43	46	48	44
8	...	...	29·89	5 8	5 5	3	270	6	480	10½	630	4 0	3 11	1 3	6	300	46	46	44	47	48	45
9	·005	113	29·58	5 8	5 6	3	270	5¼	420	7½	450	4 0	3 11	1 4	5¼	265	44	46	44	45	48	45
10	·080	1,810	29·48	5 8	5 6	2¼	200	4½	360	6¾	405	4 0	3 11	1 5	4½	225	45	47	44	44	49	45
11	·030	678	29·40	5 8	5 6	2¼	200	3¾	300	6	360	4 0	4 0	1 5	3¾	185	44	47	44	45	49	45
12	·035	792	29·35	5 8	5 6	3	270	3¾	300	6	360	4 0	4 0	1 4	4	205	45	46	44	46	48	45
13	·300	6,786	29·87	5 8	5 6	3¾	338	5¼	420	8¼	495	4 0	4 0	1 4	5¼	265	42	45	44	42	47	45
14	·150	3,394	29·20	5 8	5 5½	3	270	8¼	660	15	900	4 0	4 0	1 4	11¼	560	37	44	44	37	45	45
15	·005	115	29·46	5 8	5 5½	3	270	6	480	9	540	4 0	4 0	1 4	5¼	265	41	43	44	41	44	45
16	...	...	29·65	5 8	5 5½	3	270	5¼	420	7½	450	4 0	4 0	1 4	4½	225	43	43	44	43	44	45
17	·005	110	29·83	5 8½	5 6	3	270	4½	360	6	360	4 0	4 0	1 4	4½	225	44	42	44	44	43	45
18	...	...	29·83	5 8½	5 6	3	270	4½	360	5¼	315	4 0	4 0	1 4	4½	225	46	43	44	46	44	45
19	...	...	29·78	5 8½	5 6½	2½	200	4½	360	4½	270	4 0	4 0	1 4	4½	225	43	44	44	43	45	45
20	...	...	30·10	5 8½	5 6½	2¼	200	4½	360	4½	270	4 0	4 0	1 4	4½	225	42	44	44	42	46	45
21	...	...	30·18	5 9	5 7	2¼	200	4½	360	3¾	225	4 0	4 0	1 4	3¾	185	42	45	44	42	47	45
22	...	...	30·00	5 8½	5 6	3	270	5¼	420	4½	270	4 0	4 0	1 4	3¾	185	40	46	45	40	48	46
23	·205	4,650	29·90	5 8	5 5	3	270	5¼	420	4½	270	3 11½	4 0	1 3	3¾	185	38	46	45	39	48	46
24	...	...	30·76	5 9	5 6	3	270	3¾	300	4½	270	3 11	4 0	1 3	3	148	37	46	45	38	48	46
25	...	...	29·69	5 10	5 6	3	270	3¾	300	3¾	225	3 11½	4 0	1 3	3	148	43	45	45	43	47	46
26	·005	113	29·80	6 10	5 6	2½	225	3	240	3	180	4 0	4 0	1 3	2¼	110	39	44	45	39	46	46
27	...	...	30·00	5 10	5 6	2¼	200	3	240	3	180	4 0	4 0	1 3	2¼	110	37	43	45	37	45	46
28	...	...	30·03	5 10	5 6	2¼	200	3	240	2¼	135	4 0	4 0	1 3	1½	75	38	42	44	38	44	45
29	...	...	30·00	5 10	5 6	2¼	200	3	240	2¼	135	4 0	4 0	1 3	1½	75	41	42	44	41	44	45
30	...	...	30·00	5 10	5 6	2¼	200	3	240	2¼	135	4 0	4 0	1 3	1½	75	40	42	44	40	44	45
Total	1·440	32,586		Total quantity of water per acre discharged			6,683		10,920		10,530					6,188						
				Remainder unaccounted for			25,903		21,666		22,056					26,398						
				Total Rainfall			32,586		32,586		32,586					32,586						

HINXWORTH DRAINAGE.—Record of the Month of May, 1857.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	Rainfall.		Barometer.	Occasional Drainage.—Field No. 40. 16 Acres.—Soil, lower Chalk mixed with Clay, Gravel, and Sand. Very wet before Draining.				Part Occasional and part Wide Parallel Drainage. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed.		Paralell Drainage. Fields 13 and part 14. 24 Acres.—Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856.		Close Parallel Drainage. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay, with Lime infiltrated. Considered very stiff and impenetrable. Drains, 25 feet apart, and 4 feet deep.					Temperature. At half-past Seven, a.m.					
				Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes 8 feet deep.		Quantity of Water from Outlet No. 8, which discharges the Drain Water from Field, No. 40.		Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, five inches. Commenced running October 12.		Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year.		Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Test Holes 5 feet deep.			Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running Nov. 27.		Undrained Land.			Drained Land.		
												Drained Land.										
Day of the Month.	Per Diem. Inches dec.	Per Acre. (Per Diem.) In Gallons.	Height at the time of recording the Discharge from the Outlets, 8 o'clock, a.m. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	Higher Side.—Distance from Drain to Drain 75 yds. Depth of Drains 7 ft. 6 in.	Lower Side.—Distance from Drain to Drain 33 yds. Depth of Drains 6 ft.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Higher Side. 25 ft. apart and 4 ft. deep. No. 31.	Lower Side. 25 ft. apart and 4 ft. deep. No. 31.	Undrained Land. No. 33.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Of Air 9 inches above surface. No. 33.	Of Soil 18 inches below ground. No. 33.	Of Soil 42 inches below ground. No. 33.	Of Air 9 inches above surface. No. 31.	Of Soil 18 inches below ground. No. 31.	Of Soil 42 inches below ground. No. 31.
1	·040	905	30·07	5 10½	5 6	1½	135	3	240	2¼	135	4 0	4 0	1 3½	1½	74	42	42	44	42	44	45
2	·005	113	30·06	5 11	5 6	1½	135	3	240	2¼	135	4 0	4 0	1 4	1½	74	44	43	44	44	45½	45
3	...	...	30·17	5 11	5 6	3	270	3	240	2¼	135	4 0	4 0	1 4	1½	74	43	43	45	43	45½	46
4	...	...	30·18	5 11	5 6	3	270	3	240	2¼	135	4 0	4 0	1 4	1½	74	44	43	45	44	45½	46
5	...	...	30·19	5 11	5 6	3	270	3	240	2¼	135	4 0	4 0	1 4	1½	74	41	44	45	41	45	46
6	·010	226	30·20	5 11	5 6	3	270	3	240	1½	90	4 0	4 0	1 4½	1½	75	38	43	45	39	45	46
7	...	...	30·19	5 11½	5 6½	2¼	200	2¼	180	1½	90	4 0	4 0	1 4½	1½	75	38	43	45	38	45	46
8	...	...	30·05	5 11½	5 6½	2¼	200	2¼	180	1½	90	4 0	4 0	1 5	¾	37	40	43	45	40	45½	46
9	...	...	29·79	6 0	5 6½	2¼	200	2¼	180	1½	90	4 0	4 0	1 5	¾	37	45	44	45	45	46	46
10	...	...	29·68	6 1	5 6½	1½	135	2¼	180	2	120	4 0	4 0	1 5	1	49	44	44	45	44	46	46
11	·150	3,393	29·60	6 1	5 6½	1½	135	2¼	180	2¼	135	4 0	4 0	1 5	1½	75	47	45	45	48	47	46
12	·050	1,131	29·80	6 1	5 6½	1½	135	3	240	2¼	135	4 0	4 0	1 5	1½	75	49	46	45	50	48	46
13	·010	226	30·00	6 1½	5 6½	1½	135	3	240	3	180	4 0	4 0	1 5	1½	75	52	48	45	53	50	46
14	...	...	30·00	6 2	5 7	1½	135	2¼	180	2¼	135	4 0	4 0	1 5½	1½	75	53	49	46	54	51	47
15	...	...	30·01	6 2½	5 7	1½	135	2¼	180	1½	90	4 0	4 0	1 6	2¼	110	56	51	47	56	53	48
16	·055	1,245	30·10	6 3	5 7	1½	135	2¼	180	1½	90	4 0	4 0	1 6	2¼	110	58	52	48	58	55	49
17	...	...	30·09	6 3½	5 7½	1½	135	1½	120	¾	45	4 0	4 0	1 6	2¼	110	58	52	48	58	55	49
18	...	...	30·00	6 3½	5 7½	1½	135	1½	120	1	60	4 0	4 0	1 6	2¼	110	60	51	48	60	54	49
19	...	...	29·95	6 4	5 8	¾	67	1½	120	1	60	4 0	4 0	1 6	2¼	110	63	50	48	63	53	49
20	...	...	29·80	6 4½	5 8½	¼	23	1½	120	¾	45	4 0	4 0	1 6	2¼	110	63	51	48	64	54	50
21	...	...	29·60	6 5	5 9	¼	22	1½	120	¾	45	4 0	4 0	1 6½	2¼	110	65	54	49	65	56	51
22	·040	905	29·76	6 5	5 9½	Nil	Nil	1½	120	¾	45	4 0	4 0	1 6½	2¼	110	66	54	50	66	56	51
23	·170	3,845	29·60	6 6	5 10	Nil	Nil	2	160	1	60	4 0	4 0	1 6	3	148	64	54	50	63	56	51
24	·030	678	29·41	6 6	5 11	1½	135	1½	120	1	60	4 0	4 0	1 6	3½	173	61	54	50	62	56	51
25	...	...	29·46	6 6	6 0	1½	135	1½	120	1	60	4 0	4 0	1 6	3¾	185	60	54	50	61	56	51
26	·180	4,074	29·48	6 6½	6 3	1½	135	1½	120	1½	90	4 0	4 0	1 6	4	198	61	54	49	60	55	51
27	...	...	29·64	6 6½	6 3	1½	135	1½	120	1½	90	4 0	4 0	1 6	4	199	62	53	49	62	55	52
28	...	...	29·70	6 6½	6 4	1	90	1	180	1	60	4 0	4 0	1 6½	3¾	185	62	53	50	61	56	52
29	...	...	29·80	6 7	6 5	1	90	1	80	¾	45	4 0	4 0	1 6½	3¾	185	61	53	50	60	56	52
30	·010	226	29·89	6 7½	6 6	1	90	1	80	¾	45	4 0	4 0	1 7	3	149	62	53	49	62	56	52
31	...	...	29·95	6 8	6 6½	1	90	1	80	¾	45	4 0	4 0	1 7	3½	173	...	...	...	...	...	...
Total	·750	16,967		Total quantity of Water per acre discharged			4,132		5,040		2,775					3,418						
				Remainder unaccounted for			12,835		11,927		14,192					13,549						
				Total Rainfall..........................			16,967		16,967		16,967					16,967						

SUMMARY OF THE FOREGOING RECORDS.

MONTHS.	RAINFALL.		QUANTITIES DISCHARGED FROM OUTLETS.				MONTHS.
	Inches dec.	Per Acre. In Gallons.	From Outlet No. 7, from Oct. 1 to Feb. 28, and from Outlet No. 8 from March 1 to May 31 as per col. 7. Per Acre in galls.	From Outlet No. 9, as per col. 9. Per Acre in galls.	From Outlet No. 13, as per col. 11. Per Acre in galls.	From Outlet No. 15, as per col. 16. Per Acre in galls.	
October	1·645	37,215	12,910	178	8,915	Nil	October.
November	1·630	36,872	27,000	2,077	6,015	330	November.
December	1·235	27,935	30,565	11,895	15,935	5,825	December.
January	2·333	52,775	43,855	39,090	49,250	31,805	January.
February	·192	4,343	27,360	14,320	13,650	9,060	February.
March	·820	18,547	From Outlet No. 8, at a higher level 8,415	7,830	5,850	3,310	March.
April	1·440	32,586	6,683	10,920	10,530	6,188	April.
May	·750	16,967	4,132	5,040	2,775	3,418	May.
Total Rainfall . . .	10·045	227,240	160,920	91,350	112,920	59,936	Total discharge per Acre.
Difference between Rainfall and Discharge from the Drains ...			66,320	135,890	114,320	167,384	
			227,240	227,240	227,240	227,240	Total Rainfall.

The object I had in conducting the experiments and in tabulating the results now collected, was first, to gain tangible and irresistible proof of the draining capabilities of clay soils, and next, to demonstrate to what extent the close parallel system of drainage, so necessary for the drainage of clays, may be profitably departed from in soils of an open and irregular character by the adoption of occasional deeper drains. I selected the clay lands of Hinxworth, because they presented a surface and subsoil, and had a local reputation as forbidding as any clay lands I had visited in my practice as a draining engineer, and because the open and mixed soils were from their position exceedingly wet and cold at that season of the year—from February to May—when a free and warm bed is most required by vegetation.

In 1849, when I reported on the drainage of the Hinxworth Estate, I advised the owner, Mr. Clutterbuck, of Watford-house (who then contemplated some partial work), not to attempt the drainage in any other way than as a whole, because I considered that nearly every part was more or less dependent on adjacent lands, and that the work would only be satisfactory and complete when effected altogether, and by a connected scheme of operations. This suggestion Mr. Clutterbuck acted upon, and when the estate is viewed geologically in its relation to the surrounding district, and the several parts of the estate considered in relation to each other, I believe the value of the decision to deal with it as a whole will be fully appreciated.

In the winter of 1855-6, Mr. Clutterbuck determined to drain the whole estate. It consists of three farms, containing together about 800 acres. It lies at the base of the chalk escarpment of the London Basin, and covers a portion of the lowest bed of the chalk, the outcrop of the greensand, and a portion of the gault of the greensand formation. In several parts a superficial deposit of drifted gravel and sand overlies the older beds. The greensand separating the chalk from the gault is very thin, and, if collected in a distinct layer, would not exceed three inches in depth in its thickest part. The gault has gained a siliceous character where it comes immediately in contact with the greensand. It has also imbibed a calcareous quality by an infiltration of the chalk through the greensand into its bed; for a wide breadth, however, the gault is denuded, and there, although the greensand is absent, a very considerable infiltration of lime has taken place, which, I presume, may be accounted for by the fact, that the chalk escarpment rises in almost cliff-like shape immediately at the margin of the gault, and any submersion of the gault has necessarily imparted to it the character of its more prominent and overwhelming neighbour.

The following are several analyses of Professor Way:—

OF THE LOWER CHALK AND MIXED DRIFT.

Moisture and organic matter	3·27
Sands and clays	24·37
Silica soluble in acids	1·23
Oxide of iron	1·14
Phosphate of lime	0·92
Sulphate of lime	0·76
Carbonate of lime	68·31
	100·0

OF THE GAULT (AT 24 INCHES DEEP.)

Moisture and organic matter	5.01
Sands	0·66
Clay	63·26
Carbonate of lime	31·07
	100·0

OF THE GAULT (AT 42 INCHES DEEP.)

Moisture and organic matter	4·28
Sands	0·34
Clay	62·97
Carbonate of lime	32·41
	100·0

The whole of the lands, both those of the mixed open character and those of the gault clay, suffered greatly from excessive wetness before drainage; the water in each standing within a few inches of the surface during the spring months of March, April, and May. A connected system of works was adopted. The chalk and mixed drift soils were drained by occasional and wide parallel drains (from 4 to 8 feet deep), sufficient to discharge the rainfall and relieve the pressure of subterranean water passing through the soil from the higher grounds to their natural outfalls, at a cost varying from £1 10s. to £3 10s. per acre. The gault clay soils were drained uniformly by a parallel arrangement of drains 25 and 27 feet apart, 4 feet deep, at a cost varying from £5 10s. to £6 10s. per acre. The effect of the different modes of draining in lowering the water-level in each description of soil, is shown by the height of the water standing in the test-holes as set forth in columns 4, 5, 12, and 13. The discharge from the several outlets following rain is exhibited by columns 7, 9, 11, and 16. It will be observed that the discharge from the open soils was much more regular than from the clays, while the latter gave out a very large proportion of heavy rainfalls immediately after they occurred. A remarkable proof of the influence and penetration of atmospheric changes through soil to the depth of drains is to be seen in the fact, that all the outlets discharged an increased quantity of water on the 6th of March and 22nd of April, without any fall of rain on the surface, it being observed on each occasion that a very considerable fall of the barometer had taken place within the previous twenty-four hours.

DISCUSSION.

The Rev. J. Clutterbuck agreed with Mr. Denton as to the importance of correct records of meteorological phenomena. This principle, with regard to the measurement of rainfall, had been recognised and carried out by his grandfather, a hundred years ago. What he, Mr. Clutterbuck, considered the perfection of the registration of rainfall had been attained by means of photography. Mr. Clutterbuck proceeded to give a description of the way in which this was effected by the photographic apparatus, as employed at the Observatory at Oxford. The observations were continued day and night. The most accurate register of rainfall, as well as of the action of the wind, was by this means obtained; even the exact moment at which a shower fell was recorded. He had not unfrequently been asked what was the practical utility of keeping records of rainfall. In many cases there were absolute and tangible benefits resulting from it, and he could mention instances in which most important public works had been regulated solely by the register of the rainfall; and his friend, Mr. Dickinson, who used a rain-guage of a peculiar construction, stated some time back that he regulated his contracts for working his mills by the rain guage. In such cases, therefore, there were tangible practical benefits resulting from keeping a record of the rainfalls. With regard to floods, particularly in the river Thames, he had noticed that the amount of flood water depended upon the direction of the wind at the time of the rainfall, and the effect of this was, that when there was rain with an easterly wind no excessive flood took place. That was especially the case when the almost unexampled fall of rain took place in the month of October last. Living on the banks of the Thames below Oxford, he was then able to predict that although the rain fell in such large quantities, no serious flood would ensue, because it was an easterly rain, but if that rain had come from the west there would have been a heavy flood. He had observed that under one-third of an inch of rainfall hardly told upon the floods of the Thames. He considered that unless they had a complete system of rain guages, those who had the regulation of flood-gates could not properly perform their duty, because, if the flood-gates were drawn at one place too soon, the water was sent away too quickly, whilst, on the other hand, restraining the water too long, flooded the district above. In the supply of water to towns generally, attention to the rainfall was an indispensable condition. He thought that in the present scientific age such a paper as this ought not to be called for, inasmuch as the advantages of a correct register of the rainfull of the country should have been recognised and acted upon many years ago, and unless they availed themselves of the manifest appliances of science in promoting the social economy of the country, the next generation might justly reproach them for their culpable neglect.

Mr. C. Greaves felt indebted to Mr. Denton for his paper, and agreed with him as to the importance of a correct record of the rainfall. There was no doubt the register should be general and well tabulated, and that the work should be carried on by those who understood it, and instruments of the best description employed for the purpose. Without offering any opinion as to whether the £26,000 per annum should be sanctioned by government, he thought Mr. Denton had overrated the requirements of the case, inasmuch as at the present time a very large number of records of rainfall were kept, although they were obtained without any special commission, and the amount of information they had on the subject was really considerable. The summary of the Meteorological Society was extremely well done, and was reduced from a very large number of obeservations. There was nothing that this country was so likely to fall short of as water, for the supply of which we were dependent entirely upon our own island, and the necessity of storing and preserving it had during several years past become a matter of increasing interest. The moors were being laid under tribute. Reservoirs were constructed for the retention of water for mill power, as well as for supply of water for domestic purposes. He thought in measuring the quantity of rain that fell they only dealt with half the question. The quantity that came down was a great matter, but that which passed away in evaporation was of equal and perhaps of more importance. It was unfortunate that so many persons had established rain-guages without also providing some system of registering the quantity of water evaporated, whether from the surface of the water or the surface of the ground. This being a question of considerable interest to himself, he had made some experiments with a couple of rain-guages—a surface guage and a ground guage. Acting upon the notion that the larger they were the better, he constructed them a yard square. He placed them side by side, one of them being filled with a cube yard of earth, with grass upon the top. Attached to the bottom was a glass tube, similar to that placed within the open rain guage. The register of these two guages went on simultaneously, and the results were very fairly comparable one with the other. The result he found was, that only one-fifth of the rain that fell reached to the bottom of what he called his ground guage; and the conclusion he arrived at was, that if water went down a yard deep, or even 2 feet, it was beyond the limits of evaporation. Therefore he assumed that one-fifth only of the rain-fall went down to the springs; he considered that the registration of the rain-fall should be carried on daily. In calculating the comparative evaporation in different months and quarters of the year, he observed that not a drop of rain went down to the ground-guage during the six summer and autumn months, let it rain ever so hard. Therefore, all the water that went down to the springs did so between the months of October and March; and, taking the quantity at 5 inches, there would be 3 inches during Oct. Nov. and Dec., and 2 inches during Jan. Feb. and March. There could be no doubt that the degree of cold in this country was much affected by the amount of evaporation that was constantly going on. The evaporation of moisture from the surface was the great reducer of the temperature; and therefore, for the sake of elevating the temperature, as much as for any other object, drainage had become essential, and was, on those grounds, recommended; and the practical results had shown how much the temperature had been raised by that means.

Mr. De La Trehonnais remarked, that Mr. Denton had stated that an accurate knowledge of the rainfall was not only useful, but actually necessary for the proper drainage of the land; but during a storm an immense quantity of water might fall, and that contingency must be kept in view in drainage, in order to allow the superabundance of water to run out of the land. In his own opinion the average of rainfall had not so much to do in the way of drainage as some people seemed to imagine, because drains must be laid in such a manner as to give an outlet for the immense body of water that might come suddenly upon the land. It had been stated that water at the depth of two feet was beyond the reach of evaporation. For his own part, in his fields, he should not like the water-bearing stratum to be less than 3½ feet down, otherwise he should be in fear that the temperature of the soil would be greatly lowered.

Mr. Thomas Webster, F.R.S., said, he thought the last speaker had pointed out the real question for consideration. He (Mr. Webster) did not regard it of so much importance to know precisely the quantity of rain that fell at each place, and the observations already made were very numerous, and might, he thought, be considered sufficient. In the valuable tables published by Mr. Beardmore, there was included the record of the quantity of rain which fell in almost every place in England. Professor Lloyd had also published extensive observations in Ireland, obtained from persons employed in the coastguard service, and in those the east coast, compared with the west, gave results similar to the observations made in England. In the consideration of this question, regard must be had to the character of the district—first, as to level; secondly, as to situation—whether east or west; thirdly, inclination; and fourthly, the nature of the strata. He apprehended, if those facts were given, knowing the amount of rainfall, they could tell what would be the amount of outfall they must provide for artificial drainage. These were practical questions belonging to the agricultural engineer, and could only be solved by those who had a knowledge of the various localities. Therefore, he thought the establishment of observations by paid observers was hardly worth the expense, for, as regarded the general laws of the distribution of rain, the quantity was ascertained within two or three inches, but how it was to be dealt with was so much a matter for individual localities, that they must look to those interested in the question to deal with it. The remark of Mr. Greaves was a most important one, viz., that only one-fifth of the rainfall went to feed the springs, and that four-fifths went off by evaporation. He had often considered how an accurate test of evaporation might be obtained, and he thought the notion of the cube yard of earth was an extremely valuable one. With regard to rain guages, he recollected that when Professor Lloyd read a paper on the subject before the British Association at Belfast, some advocated a spherical rain guage, as it was argued that by this means whichever way the wind blew the entire rainfall was registered. A comparison of the various guages might, however, be easily made. With regard to the easterly and westerly rains mentioned by Mr. Clutterbuck, the rain during a dry east wind was due almost entirely to the condensation consequent upon the cold and dry wind coming from the North Pole. Therefore, when they had a fall of rain with an easterly wind, the quantity absorbed by evaporation was enormous as compared with that evaporated during a westerly wind. This would account for the difference in the amount of floods which had been mentioned.

Mr. Robert Rawlinson said that civil engineers fully recognised the use of the rain-guage, and he (Mr. Rawlinson) agreed with Mr. Webster in thinking Mr. Denton had rather underrated the value of existing records as to rainfall, returns having been published which were easily accessible for England, Scotland, and Ireland. To establish a national system of rain-guagings must be very costly, and the results would only be useful to a limited extent. A national survey was useful, but it would not prevent the necessity for special surveys for special purposes. No nation could do the work of individuals, nor ever would do such work. With respect to the fall of rain, as connected with town sewerage and land drainage, registration of volume was only useful to a limited extent. No engineer could deal with maximums, as the excesses could not be reserved in either sewers or drains, but must pass away in a natural manner over the surface. From careful registration and from tolerably accurate guagings of volume at outfalls, in one case over an area of steep mountain district rising more than a thousand feet, and in a second case from a tolerably flat and porous soil and subsoil, it was found that the maximums in both cases were almost identical, and that these maximums, as compared with the minimum flow, reached almost every year as high as 300 to 1, and occasionally even to 400 for short intervals; that is, a natural stream having one gallon per minute flowing down during a continuance of dry weather, had, in its annual floods, three hundred gallons in a similar time; and, at longer intervals, even up to four hundred gallons. This, he believed, would be found, more or less, to be the case throughout Great Britain, whether the annual rainfall was 20 inches or 40 inches—as the district of least annual fall might have thunderstorms of short duration, but heavier than any which took place in a locality were the rain fell in a greater number of days. The engineer should pay especial attention to excesses of rain and to flood outfalls, and he would find that he could not deal with such vast volumes of water either in sewers or in drains. The Ouse at York, and the Eden at Carlisle, had each a flood rise upwards of 20 feet in vertical height, and vast areas of valley land were covered at such times. Then, as to the work sewers and drains had to do, the subsoil water must be taken into account, and this would be found greater than was generally imagined. The contemplated low level intercepting sewers for metropolitan sewerage, if ever made, would, in his opinion, actually be filled permanently with subsoil or spring water. Rivers were the natural drains of a country, both for surface and for subsoil. The banks of the Thames were full of springs, and much of the subsoil was quicksand. Brick sewers would admit the water, and not unfrequently the fine sand. The mischief and danger of large and deep sewers in such strata, could hardly be overrated. The excessive volume of spring water would remain to be pumped, where there was no natural outlet—that is, below ordinary low water. In several towns in which public sewers had been carried out, the flow, during dry seasons, had been guaged, and the excesses of surface and of subsoil-water found in the sewers at such times were, in one case, five to one, and, in a second case, nine to one —that is, the sewage due to water supply was taken as one, and the subsoil-water and surface-water, at the driest times, five and nine. In both these cases there was a natural outfall. At Worthing, where the whole of the sewage and subsoil-water had to be pumped, the excess of subsoil-water was even greater. English engineers were now engaged in all parts of the world, and a knowledge of the laws of nature was indispensable to prevent fatal blunders. If, in Great Britain, maximums of floods up to 400 should be provided for, in the tropics maximums of thousands must be anticipated. There were natural phenomena to be observed, which might teach the engineer at a glance what he ought to expect, such as dry ravines, full of the evidences of water; the bare sides of mountains, and the absence or presence of peculiar vegetation; the one destroyed or swept off by floods of water, the other produced by such floods. In all cases the engineer must guard, above ground, against maximums, and, as far as is possible, ascertain what these were likely to be, and then work on the safe side. In all cases the rain-guage should be consulted for minutiæ and for details; but for maximums, such as land-floods, valley outfalls of streams and rivers must be guaged.

The **Chairman** said he was quite sure that all present would agree with him in considering the Society to be much indebted to Mr. Denton for having brought this subject under consideration. It had been treated by Mr. Denton chiefly with reference to drainage, a subject with which he was specially conversant, and he had also made some allusions to other and more general purposes, for which an accurate register of the rainfall in Great Britain would be valuable. He (the chairman) however, could not close the meeting without observing that he thought the plan of having a register kept at every five or ten miles was not required by the circumstances of the case, and he thought the reasons for this had been clearly stated by several gentlemen who had taken part in the discussion. He considered that every one must feel that, though it was extremely desirable to have extensive and correct information on the subject of the rainfall, yet they must not, as a Society, endeavour to aim at any object in a way that might appear to be merely theoretical, or to be attended with too much refinement, or involving an amount of public expenditure which there was no chance whatever of the government—at least for some length of time—being likely to sanction. He did not think that the government would be willing to appropriate £26,000 a year merely for the purpose of obtaining correct registers of the rainfall throughout the country; and looking, as he had recently done, with much attention at the existing state of information, he found that a vast quantity of detail was available for publication in the ordinary proceedings of Meteorological and other Societies, and by individuals taking an active interest in the subject. He had looked over records kept by Mr. Glaisher, extending back over a long period of years, and derived from accurate observations made throughout the kingdom, and although additions might, and he hoped would be made, yet practically, he thought that nearly all was attained that was of direct value in a public point of view. As to special cases, requiring detailed attention, these must be separately dealt with. He held in his hand a map prepared by Mr. Denton, which purported to show the different places where registers of rainfall were kept, and in examining this map he first looked at the district with which he was best acquainted, and he found that two places, where registers were kept under his own superintendence, were omitted. In these places very accurate observations had been made, and, in one case, previously to his taking up the record, a meteorological register had been kept by the Rev. William Walton for a period of about thirty years. It had been very correctly observed, by more than one of the gentlemen who had spoken, that as regarded drainage, it was not any nicety of calculation that was required as regarded the mean rain-fall, it was the maximum that must be provided for, and not only so, but a liberal margin as well. But in order to know the maximum in different districts a correct register was necessary, so that due preparation might be made for extraordinary falls, and in this again the element time was important, as a daily register alone would not convey an idea of the quantity of water for which it might be necessary to provide the means of removal. In the district to which he had made allusion, he had witnessed a fall of rain of 2·84 inches in less than four hours. That was an extraordinary amount of rainfall, and it was indispensable for the safety of houses and other property that proper outlets should be provided, but unless careful observations were extended over a long term of years it would not be possible to adopt measures of prudence without incurring unnecessary risk or an undue expenditure. But there was another and very important phase in which the subject of Mr. Denton's paper might be viewed, and that was the great value of an accurate knowledge of the amount of water available for power to be applied to engineering or mechanical purposes. He did not now wish to raise a question foreign to the subject immediately before them, as regarded the existing quantity or probable duration of coal, but supposing that, either in particular districts or generally, the expense of procuring coal was increased, or any falling off in the supply occurred, it would then be desirable to use a cheaper source of power, and such a source of power in almost immeasurable abundance was capable of being applied by the use of streams, which were now considered as comparatively valueless. He regretted that the lateness of the hour prevented his going into details, but he would very briefly observe that in one of the mining districts under his direction the mountain streams were collected into reservoirs, and directed by means of water races or pipes, so as to act on all the various kinds of engineering or mechanical work required, and a power equal to more than five hundred horses was thus available, and was now either in operation, or in full progress towards completion. The mere power of a stream of water might not suffice for the required objects, but by employing a wheel constantly in one direction, forcing pumps were worked so as to be at all times raising water into the interior of a cylinder, where it was subject to a pressure from a vertical piston loaded to the weight of 40 or 50 tons. The water which was thus being constantly—day and night—stored up in this magazine of power, remained there subject to the enormous pressure which had been gradually overcome; it was accumulated as a store to be used in three, four, six, or ten hours, as the case might be, and the apparatus, which was the patented invention of Mr. W. G. Armstrong, of Newcastle, was called an *accumulator*. He could speak most strongly as to the simplicity and value of this arrangement, by which it was obvious that wherever circumstances were favourable for the collection of streams at an elevation of even a few feet, the hitherto neglected power of such streams might be made available to a much greater extent than they could possibly have been under the system of water wheels alone. This subject, be believed, for the reasons to which he had alluded, to be of more importance than was commonly supposed, and he need scarcely observe how valuable for such purposes would be any information as to the amount of rainfall and evaporation, as also of the maximum and minimum quantity of water in streams and rivers. Another point, and a very interesting one, had been adverted to, viz., the best form of rain-guage to be employed. He could not now go into the details of that question, but it was a subject worthy of great attention, and any information on which could not be too highly prized. He met with anomalies for which he could not account, and he trusted that the Institutions throughout the country would take up this inquiry in their respective localities. Indeed, he hoped that the numerous and very interesting facts and observations to which Mr. Denton had called their attention, would create and extend a taste for meteorological observation, and thus be a means of providing records in such parts of Great Britain as were so far inadequately represented. He had much pleasure in saying that the Institution of Civil Engineers, appreciating the practical value and importance of such knowledge, had liberally placed the meeting room of that Institution at the service of the Meteorological Society for its meetings, which would admit of their being more numerously attended than they had hitherto been. Mr. Denton, in his paper, had aimed at a very large system of methodical registration, and although he (the chairman) felt that the time had not yet arrived for such large requirements to be met by the government of this country, yet the consideration of the subject by this Society, and the valuable observations offered during the present discussion, would tend to arouse the attention of agriculturists, engineers, and of the public generally, and lead us, he hoped, to the further perfecting of the arrangements now pursued by the Meteorological Societies and others. He begged to propose a vote of thanks to Mr. Denton for his extremely interesting and valuable paper.

A vote of thanks was then passed to Mr. Denton.

Mr. DENTON, having acknowledged the compliment, said—In the first place he would state that the omissions in the plan alluded to by the chairman were entirely owing to the fact that he could not find those places on the map, and could not obtain sufficient information to enable him to put them upon the plan with authority. The map showed, by dots, every station in England recognised as authoritative, which amounted to 120 stations, and these, he submitted, were as nothing compared with the number they ought to have. The evaporation from land must depend upon whether there was a vent below, that acted as a means of discharge, by which the water might flow out of the soil as soon as it got into it. If drains existed below, they removed a large quantity of the rain as it fell, and by that means diminished, if not entirely prevented, evaporation. If there was no drainage below, the soil was kept in a saturated state until evaporation released the water. Therefore, to arrive at a result, without taking into consideration both these circumstances, was not fair reasoning. Some questions were asked as to the depth and distance to which drains should be dug under varying circumstances of rainfall. He (Mr. Denton) had already stated that they had before them this glaring fact, that upon soils of precisely the same mechanical and geological formation—take, for instance, the lias, running from north to south,—in some places they had 37 inches and in others 21 inches, and the number of days of rain would vary considerably. He would put it to those present whether that fact must not have a direct influence upon the drainage of the land—a difference of 16 inches in the rainfall, or equal to the entire rainfall of Essex; and it was opposed to all reason to suppose that so great a difference as 1,600 tons of water falling on the surface should not have a considerable effect. It could not be right to treat the two instances in the same way.

The Secretary announced that on Wednesday evening next, the 20th inst., a paper by Mr. William Clay, "On the Manufacture of Puddled and Wrought Steel, with an Account of some of the Uses to which it has been Applied," would be read.

SOUTH KENSINGTON MUSEUM.

During the week ending 9th January, 1858, the visitors have been as follows:—On Monday, Tuesday, and Saturday (free days), 3,439; on Monday, and Tuesday, (free evenings), 2,528. On the three students' days (admission to the public 6d.), 635. One students' evening, Wednesday, 85. Total, 6,687.

Home Correspondence.

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MR. UNDERWOOD'S PAPER ON INK.

SIR,—May I be permitted to make a few remarks on Mr. Underwood's paper on inks. Having had considerable experience in this manufacture, I am well acquainted with its peculiar difficulties. From my numerous experiments, I feel convinced that it is not from any solution of logwood that an advance and improvement in the manufacture of ink can be made. Logwood, and extract of logwood, has long been used, in all proportions, with gall nuts, metallic iron, and iron salts. The more logwood, the commoner and cheaper the ink, such as school ink, &c. Now, how a patent can be claimed for any such combination in any proportion whatever, I cannot conceive. The principal feature of Mr. Underwood's paper, viz., the use of "chromate of potassa," your correspondent Mr. B. Winstone has justly observed was invented by Professor Runge. The recipe, just as Mr. Winstone has quoted it, was copied into all the cheap journals of the day, viz., some four or five years ago, and recommended as a very cheap ink for steel pens. A German got hold of it, and went about London among the stationers selling the recipe; many were victimised, as the product was worthless. I have some writing in my possession with this ink, carefully prepared, and it has quite faded, as might be expected. He also stated that he saturated copying paper with the chromate salt, and wrote with logwood solution. In the discussion which took place, Mr. May justly questioned the durability of any compound of logwood. Mr. Deputy Lott seemed to think if its indelible character could be proved, it would be valuable to the legal profession. No doubt an indelible ink would be, but certainly any logwood ink would be dangerous to rely upon. The only real scientific advance in this manufacture was made by the celebrated chemist Berzelius, from the rare metal "Vanadium;" this is, unfortunately, so scarce as to preclude its use for this purpose. It was stated to be indelible. The chemical action of chromate of potassa upon solutions of logwood, is an oxidising one. The colouring principle of this wood was first extracted and investigated by Chevreul, the French chemist; it is termed "Hematoxylin," and deposits in brownish-yellow prismatic crystals. By contact with air or oxidising agents, it is converted into "Hematin," which is granular and of a purplish black hue, and this is what is produced on the copying paper saturated with the chromate salt, when placed in contact with logwood ink. Very common inks are made with large proportions of logwood, or extract of logwood, from the fact of their being produced at about 4d. per gallon—very small quantities of iron salts being requisite. The chromate ink of Runge is still cheaper. I am now engaged with experiments on indelible ink, and trust some future day to lay the results before the Society, as the subject is one of some importance.

I am, &c.,
ROBERT PINKNEY.

18, Bread street Hill, E.C., Jan. 11, 1858.

Proceedings of Institutions.

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CROSBY-HALL.—EVENING CLASSES FOR YOUNG MEN.—On the 7th Jan. a lecture was given by S. C. Hall, Esq., F.S.A., Editor of the *Art Journal*, and the author (with Mrs. S. C. Hall) of "Ireland: its Scenery and Character." The subject of the lecture was "The Fairy Legends of Ireland." The purpose of the lecturer was to amuse rather than instruct, although his lecture contained much information concerning Ireland, and especially those local peculiarities which are rapidly fading away before the advance of education. The fairy legends of that country are now to be found only in books, or in the memories of those who gathered them long ago; so it is, indeed, although to a less limited extent, with the almost proverbial wit and humour of the Irish peasantry. The lecture was enlivened by many illustrative and characteristic anecdotes. The following is the syllabus of the lecture:—"Universality of faith in Fairies—The essentially poetical character of Irish Fairies—Their meeting places, &c.—Fairy changelings—The Phooka—the fiend spirit of the Morass—The story of Daniel O'Rourke and the Aigle. The Banshee. The White Lady of Sorrow. The Cleuricaune—The Irish treasure-keeper. The Dullahaun—Spirits without heads—Perils of Ned Sheehy—The Thierna-naoge—The land of perpetual youth—Stories of Ossian's white cows, and the holy monk of Aghadoe. The Hy-Brasil—The Isles of the blest. The Merrow—the Irish Mermaid—Story of John of the Glyn. Monastic Legends—Glendalough—How St. Kevin got rid of the last of the Serpents. Illustrative Anecdotes of the humour and pathos of the Irish character—Irish Bulls—Irish Brogue—Irish Beggars, Waiters, Car Drivers, &c.—The ever-ready wit of the Irish peasantry. Summary of the high capabilities for good of the Irish people. Impressions of the lecturer regarding Ireland as resulting from frequent visits, and from journeys through many of the highways and by-ways of the country."

Birmingham.—On Monday evening the 11th inst., a lecture was delivered at the Midland Institute, by the Rev. C. P. Wilbraham, a friend of the President, Lord Hatherton. Having seen a good deal of the world, chiefly while an officer in the army, the reverend gentleman entertained a numerous audience for nearly two hours, as he told of his "adventures in four quarters of the globe." The lecture was a pleasant bit of instructive gossip.

MEETINGS FOR THE ENSUING WEEK.

Tues. Royal Inst., 3. Prof. Huxley, "On Vital Phenomena."
Civil Engineers, 8. Discussion upon Mons. Guérin's Paper "On Railway Brakes," and Mr. T. S. Sawyer, "On self-acting Tools for the Manufacture of Engines and Boilers."
Pathological, 8.
Statistical, 8. Col. Sykes, M.P., "On Public Works in India."
Wed. Royal Soc. Lit., 4½.
Society of Arts, 8. Mr. William Clay, of the Mersey Steel and Ironworks, Liverpool, "On the Manufacture of Puddled and Wrought Steel, with an Account of some of the Uses to which it has been applied."
Geological, 8. I. Dr. C. Daubeny, "On the Emanation of Ammonia from Volcanoes." II. Rev. Prof. S. Haughton, "On some of the Granites of Ireland." III. Dr. J. J. Bigsby, "On the Classification and Stratigraphy of the Palæozoic Rocks of the State of New York."
Thurs. Royal Inst., 3. Prof. Tyndall, "On Heat, considered as a mode of Motion."
Philosophical Club, 5½.
Antiquaries, 8.
Chemical, 8. I. Dr. Gladstone, "On the Mutual Reaction of Salts in Solution." II. Dr. Noad, "On the Chemical Differences of hot and cold Blast Iron." III. Dr. Bird Herapath, "On the Iodo-sulphates of the Cinchona Alkaloids."
Linnæan, 8. Prof. Huxley, "Memoir on the Organic Reproduction of *Aphides*."
Philological, 8.
Royal, 8½.
Fri. Royal Inst., 8½. Prof. Tyndall, "On some Physical Properties of Ice."
Sat. Royal Inst., 3. Mr. Bloxam, "On the Chemistry of the Air."
Medical, 8.

PATENT LAW AMENDMENT ACT.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

[*From Gazette, Jan.* 8, 1858.]

Dated 5*th November*, 1857.

2806. Godwin Ratler Simpson and David Caldow Simpson, No. 78, High-street, Whitechapel, and No. 6, George-terrace, Commercial-road—Improvements in spring blinds.

Dated 19*th November*, 1857.

2906. Philip Edward Coffey, Bromley, Middlesex—An improvement in the process of distilling.

Dated 16*th December*, 1857.

3088. James Thornton, Nottingham—Improvements in apparatus used for the manufacture of carpets and other cut pile fabrics.

Dated 18*th December*, 1857.

3114. Robert Oxland, Plymouth—Improvements in the manufacture of alloys or compounds containing metallic tungsten. (A communication.)

Dated 19*th December*, 1857.

3116. Asa Lees and John Clegg, Soho Iron-works, Greenacres Moor, near Oldham, Lancaster—Certain improvements in looms for weaving.
3118. Richard Furnival, Manchester—Certain improvements in machinery or apparatus for cutting paper, cardboard, and other similar articles.
3120. Richard Archibald Brooman, 166, Fleet-street—Improvements in signalling, in order to prevent collisions between trains upon railways. (A communication.)
3122. John Bartlett, Bristol—An improvement in weighing machines.

Dated 21*st December*, 1857.

3128. James Hamilton, Liverpool—Improvements in ship building.
3130. Robert Rennie, Netherwood, Dumbarton—Improvements in self-acting trap doors for mines.
3134. James Tatlow and Henry Hodgkinson, Wirksworth, Derby—Improvements in railway breaks, and in apparatuses for connecting shafts or rods for working breaks and signals.
3135. William Basford, No. 15, Lowther-cottages, Liverpool-road, Islington—Improvements in the manufacture of gas, and in retorts and other apparatus to be used therein.
3138. Richard Ford Sturges, Birmingham—A new or improved manufacture of rollers or cylinders for printing fabrics.

Dated 22*nd December*, 1857.

3140. Samuel Rodgett and Daniel Rodgett, Blackburn—An improved method of coupling and uncoupling railway, tramway, and other carriages, waggons, lorries, trucks, and other vehicles.
3142. Morris Landou, 25, Pudding-lane—Improvements in cooking utensils.
3144. Edwin Maw, Doncaster Iron-works, Yorkshire—Improvements in ornamenting and strengthening metal tubes and rods with wood, applicable in the manufacture of bedsteads and other articles of furniture and framings, and also in the manufacture of the joints or connections of the posts and framings of bedsteads and other articles of furniture and frames.

Dated 23*rd December*, 1857.

3150. Augustus Frederick Kynaston, R.N., Plymouth—An improved slip or disengaging hook.
3152. John Murray, Whitehall-place—Improvements in propelling ships and vessels. (A communication.)
3154. Alexander William Williamson, 16, Provost-road, Haverstock-hill—Improvements in treating scammony root and commercial scammony, to obtain the active principle therefrom.

WEEKLY LIST OF PATENTS SEALED.

January 8th.

892. Wm. Edmondson Jones.
893. John Talbot Pitman.
895. Thomas Frederick Henley.
935. François Burot.
940. Murdoch McKay and Henry Forfar Osman.
962. William Henry Gauntlett.
2006. Joseph Conway.
2010. Frederick Warner.
2032. William Johnson.
2046. George Tomlinson Bousfield.
2052. Octavius Henry Smith.
2104. John Elce and John Leech.
2160. George Tomlinson Bousfield.
2274. George Tomlinson Bousfield.
2616. Thomas Bell.
2682. Frances Windhausen.
2776. Joseph Fry.

January 12th.

1941. Henry Starr.
1943. Nicholas Williams and Thomas Williams.
1054. Henry Hebblethwaite, William Shuttleworth, and William Tasker.
1956. Wm. Stettinius Clark,
1959. Gustavus Palmer Harding.
1963. François Moulin.
1964. William John Locke.
1972. Wright Jones.
1973. James Wright.
1974. John Cox.
1977. George Samuel Mathews.
1985. Thomas Clunes and John Mackintosh.
1988. Thomas Roberts and John Dale.
2005. Henry Vennor Cowham.
2017. Joseph Kirby.
2054. George Tomlinson Bousfield
2083. Thomas Forsyth.
2149. William Edward Newton.
2185. William Edward Newton.
2318. Archibald Turner.
2460. William Edward Newton.
2583. Thomas Massey & Thomas Savage.
2739. Thomas Richardson and Manning Prentice.
2661. Thomas Massey & Thomas Savage.
2674. William Edward Newton.
2697. Thomas Cardwell.
2731. Abel West.
2757. William Clark.
2883. Solomon P. Smith.

Patents on which the Stamp Duty of £50 has been Paid.

January 4th.

31. Robert Ashworth & Samuel Stott.

January 6th.

42. William Grindley Craig.
99. John Charles Pearce.
123. David Davidson.

January 7th.

66. Henry Bessemer.
67. Henry Bessemer.
72. Alexander Robertson.

January 8th.

71. John Norton.

January 9th.

63. William Thomas Henley.
88. William Barningham.

WEEKLY LIST OF DESIGNS FOR ARTICLES OF UTILITY REGISTERED.

No. in the Register.	Date of Registration.	Title.	Proprietors' Name.	Address.
4043	Jan. 9.	Ballast or Shovel Hoe	John Gordon	3, Railway-pl., Fenchurch-st.